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Design, Construction and Use of Metal Flumes

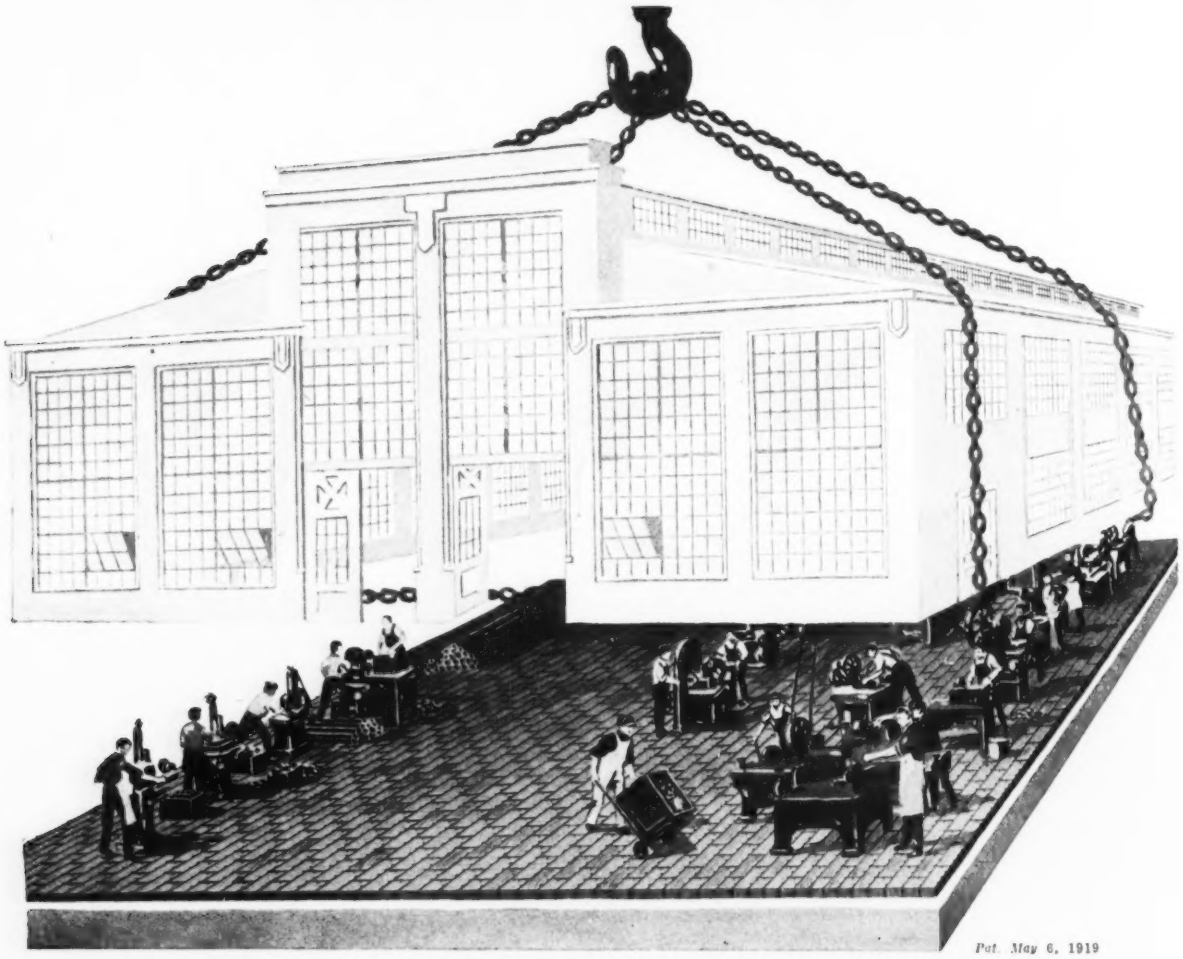
By Julian Hinds
of the U. S. Reclamation Service

Report of the Meeting of the American Water-Works Association

From Job and Office
Hints that Cut Cost and Time for Average Engineer and Contractor

KREOLITE WOOD BLOCK FLOORS

Outlast the Factory



Pat. May 6, 1919

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

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Metal Irrigation Flumes

SINCE the U. S. Reclamation Service is one of the largest users of metal flumes for irrigation purposes the results in design, construction and maintenance as given elsewhere in this issue by Julian Hinds are doubly valuable. The information on friction factors with various types of joints, limiting stresses on the design of supporting structure, protective coverings and preliminary experience with zinc plates could hardly be duplicated in any other single organization. Flume deformation data is available so that designers may know of clearances. As to life some engineers may disagree with Mr. Hinds' estimate of 15 to 20 years but he distinctly states that metal flumes have been in service too short a time to make an authoritative statement. In favorable locations, with tar paint and creosoted timber supports the period may reasonably be expected to be considerably extended. As to the hydraulics enough experimental data are now at hand to enable the designer to get the required quantity through flumes with a freeboard with a sufficient factor of safety to prevent slopping over even when carrying floating matter.

A Business Milestone

LAST week's meeting of the Chamber of Commerce of the U. S. A. marked the completion of the first ten years of the chamber's life. It was launched in 1912 under the inspiration of President Taft and his secretary of commerce and labor, Mr. Nagel. Hardly had it developed its machinery before the European war set in, bringing a host of problems that properly belonged to a national business organization. Under able leaders, it functioned well and vigorously, its strength growing rapidly, particularly after we entered the war. Today, though in its 'teens, it is a well matured organization—matured by the fire of war for the service of peace. It has wide support in the business world and is looked upon as an authoritative agency for the expression of the views of American business. Congratulations in generous measure are due those who have directed its growth and have given it its high ideals. The public's interest they have made paramount. On that sure foundation an enduring edifice can be erected.

Self Government in Industry

WE TAKE the title of this editorial from the *New York Times* of May 22, in which that paper comments on the organization of the American Construction Council as a "reassertion of our racial instinct for local self-government." The *Times* is right. It is a movement of self-government on the part of the construction industry—of self-government based on the theory that the industry exists for the service of the public and, therefore, cannot tolerate within itself any practices that are contrary to the public interest. Its launching is an appreciation, too, of what Secretary Hoover has emphasized—that industrial ills are not curable by legislation or jails. These are local palliatives. The true cure must come from a cleansing of the body from within. The reception which the movement has had at the hands of the press is an indication of public approval of business self-government when based on sound principles.

The Water-Works Convention

NEVER in the history of the American Water Work Association has a better program been presented than the one at Philadelphia last week and never has the printed program been carried out more closely to schedule. The variety of subjects and the number of topics presented were large. The papers were real contributions to available information, including even the more purely descriptive papers. Particularly commendable features of the program were the large number of committee reports and the many contributions by members of the Chemical and Bacteriological Section. The committee reports, resulting from the recent formation of the Council on Standardization, and its 17 sub-committees, were all progress reports, as would be expected from new committees dealing with complex subjects; but these reports all showed real progress instead of the time marking so common at many previous conventions of this and other associations. If the various committees keep up the pace set by their own action and by the Council on Standardization, the new impetus which the council and its committees have given to the association will produce results of great and lasting value.

Committee Problems

PROBLEMS presented by the rich promise of the standardization committees of the American Water Works Association include the finding of space and money to print the committee reports, whether in the association *Journal* or separately. These reports may perhaps be made fairly brief in themselves but the voluminous data of great potential value which some of the committees have already accumulated and others give promise of amassing will make their publication and wide circulation almost imperative. Would not the value of this committee work be enhanced and the chances of securing the private subscriptions that may be needed, if the reports are not to be buried from general view and use, be increased if all the standarization reports were published separately rather than scattered through the *Journal*? Another committee problem is the avoidance of duplication of the work of committees of other societies and the raising of jealousies between these societies and committees. Already, it appears that the creation of a water works association committee on standards for water analyses is not welcomed by the like committees of the American Public Health Association whose standards, after several revisions, are widely used. Here there is perhaps more

than ordinary need for diplomacy—for reasons more or less obvious that need not now be discussed. Other of the American Water Works Association committees are already securing co-operation from the committees of sister organizations, or are continuing such co-operations previously established—notably in the case of the New England Water Works Association, where the need for co-operation is urgent and its benefits plainly evident. Standardization must proceed by unification rather than multiplication.

Municipal Ownership in Detroit

DETROIT has taken over its privately owned electric railway system and now possesses the largest municipally owned electric railway system in the country. We wish the city well. Under so virile and able a man as Mayor Couzens municipal operation gives high promise. Nevertheless we cannot enthuse. Possibly we are hopelessly old-fashioned. We find it difficult to get away from the conviction that the proper purpose of government is to protect the rights of individuals and to prevent their invasion by other individuals or groups of individuals. Under this theory government would take over other functions only when there was clear proof that they were necessities and that no other agency could be entrusted to carry them on. Eventually there may come a day when character and ideals will have so developed that large enterprises can be entrusted with assurance of efficiency to governmental management. American experience, however, does not justify us in believing that we have yet reached that stage in this country. Our municipal operations generally are not matters of legitimate American pride.

Specifying Results or Methods

AN EVENING'S discussion in the New York Section of the American Society of Civil Engineers recently on the subject of whether specifications should contain much or little detail brought to the front the old and yet ever active problem of how to specify. Shall the engineer specify the results that he demands, or shall he specify the methods by which the expected results are to be brought about? If he specifies methods, may he also specify results, either directly or by reserving the right to protest if the results are not as good as he expected? Essentially these questions have always been a prime source of trouble between engineer and contractor. We fear they will continue in this unhappy position. The difficulty is that some specification of methods is unavoidable in every piece of work, if only as a matter of describing what is really wanted; and, further, in a great many instances it is very much simpler to describe quality by stating the method of doing the work than by attempting to picture the result and tell how that result is to be measured. Suppose a wall is to be painted and suppose that the desired result is a certain color, finish, degree of protection, and durability; by far the easiest way to lay down these requirements is to tell the painter what paint to apply and how. Thus the specification of method obtrudes itself. The real problem, then, is not whether results or methods shall be specified, but at what point it is possible—and wise—to stop specifying method and state results instead. There is no problem or subject in the whole range of construction engineering, we believe, that penetrates so deeply into all ramifications of the art and its underlying sciences. Correspondingly, there is no subject which will better repay careful consideration and reconsideration.

Detail in Building Codes

POINTED questions of engineering responsibility are contained in the problem of safe building and regulation of building practice. Building codes are themselves engineering specifications, and the manner of specifying—by a result or method—affects the engineer's relation to his work in designing buildings. A building code confined to results desired and nothing more than fundamental requirements of engineering would necessarily place the responsiblity for all the detail working out of a building structure upon the engineer. The common type of building code does not do this, but aims to prescribe in detail just what construction shall be used in each element of a building. Current building-code practice, in other words, is headed in the direction of telling a man that floor slabs in the upper stories of loft buildings must be 4 in. thick and on a 6-ft. span, must have 0.82 per cent of mesh reinforcement, must be made of 1:2:4 stone concrete, etc., etc. Such a code tends inevitably to make structural engineering automatic, and leads to the result that a bad structure is blamed not on the designer but on the building code. The opposite type, which in the extreme would fix basic loads and unit stresses and then specify nothing more than that the completed structure must satisfy every requirement of first-class construction, has never been tried. Very likely it would prove just as unworkable in practice as an engineer's specification that aimed to prescribe results alone, but the fact remains that the detail-specification type of code has proved itself incapable of preventing bad construction or disastrous building failures. Its chief defense, in the face of these failures, is that codes are not adequately enforced. This very justification, however, constitutes something of an indictment of the whole system. A real solution of the building code problem ought to be discoverable by the route of placing full responsibility on the engineer for structural adequacy of buildings; with responsibility so placed, we need have no fear that the profession will fail to live up to its charge. Under the present system we are likely to proceed farther and farther in the direction of rigid check of plans and inspection of work.

What of Genoa?

SHALL we call the Genoa conference a success or a failure? Light is thrown on this question not only by the news from Europe but also by the statements of Secretaries Hughes and Hoover since the receipt by the United States of an invitation to attend the forthcoming conference at The Hague.

Success may be measured against either of two standards—what one wants, or what one needs. Measured by the first of these, Genoa must be written down as a failure, dismal and absolute. Each of the principal conferees went to Genoa with a purpose. That of the British Prime Minister was broadest, for he sought the re-establishment of economic relationships on whatever terms, so that trade could be resumed and England exchange her industrial products for things to eat. The German Chancellor went to Genoa in the hope that by trading on British needs he might lighten the repa-

rations burden, or, failing this, drive a wedge into the Entente and isolate France, Germany's principal creditor. The French Government, on the other hand, feared the conference and sought only to prevent any action what might relieve Germany of her reparations obligations and to forestall any attempt to limit the strength of the army on which it would rely, if necessary, to exact payment. France needs cash rather than trade. Soviet Russia sought two objects; de jure recognition and a loan.

None except France, whose purpose was negative, got what he was after. Europe is still an economic mess, the reparations have not been modified, the Entente is intact, although somewhat strained, and Russia is still a thrice-bankrupt pariah.

But, as viewed against the second standard, he would be blind who would call the Genoa conference a failure. It has shed much light and effected much disillusionment. All concerned appear to have learned something from their mutual contacts and reactions. Lloyd George has learned that other European governments are not inclined to sacrifice their national interests or pride to the commercial needs of Britain or the political exigencies of a British Premier. The French Government has learned that it is not likely to extract blood from a stone and that the world in general will regard coldly military reprisals on a bankrupt debtor. The German Chancellor must realize that Germany will have to pay to the limit of her ability and that his own diplomatic ineptitude has served to prevent the rift in the Entente that he so much desired and that at one time appeared to be imminent. The Bolsheviki have learned that it is easier to hoodwink the peasants of Russia than the governments of Europe and the United States.

So much for political lessons. But what is most valuable are the economic lessons that have been taught. We say "taught" advisedly, for whether they have been learned remains to be seen. One of these is that European national debts can be paid only out of earnings, that earnings are impossible without trade, and that trade consists of a mutual exchange of goods. Another is that financial stability depends on living within one's income, which, in the case of nations, means the balancing of budgets by spending less and producing more rather than by printing paper money to redress a debit balance. A third is that credit must rest upon confidence, which in turn follows upon the enforcement of property rights, the observance of contract obligations, and the preservation of the freedom of labor.

Whether France and Germany have learned these lessons we shall see at the reparations conference to be held at the end of this month. Whether Russia has learned them we shall see at the adjourned session of the Genoa conference to be held in June at The Hague. Until these lessons have been learned; until France is willing to listen to reason on reparations; until Germany, as a bankrupt debtor, is ready to have her finances supervised; and until Russia realizes that she cannot expect to sit in the game unless she subscribes to the rules; little can be gained by American participation. When these ends have been accomplished nothing can be gained without that participation and nothing is more sure than that it will be forthcoming. American investors have already shown their willingness to finance the honest and trustworthy borrower who would apply his credit to productive rather than destructive undertakings.

The Road Builders Association

IF THE turbulent annual meeting of the American Road Builders Association on May 15 were merely a matter of petty internal politics it could well be passed by without comment. For many years, however, dissatisfaction has been expressed with the management of the association. Before road building had developed into the great industry it has now become the kind of control common in a small local engineering organization might have been adequate. The feeling today is that the administration of the association has not measured up to its opportunities, that there has been a distinct lack of business method and vision. The contest at the recent meeting, therefore, was not so much one of personalities as of principles. The fact that the older faction apparently won, amounting to an endorsement of the past policies and management, has given a good deal of concern to those who would like to see the association handle its job more effectively. That is the real issue.

No one in touch with the association's affairs can have failed to detect the rumblings that have been current. Criticism has come not only from the members, but also from manufacturers who feel that the Good Roads Show can be handled far more efficiently than it has been in the past. In fact, this sentiment was brought to a head at this year's show in Chicago by the appointment of an Exhibitors Committee heading a manufacturers' organization and it is well known that manufacturers would welcome the opportunity of displaying their products at the annual meeting of the American Association of State Highway Officials. Another movement which is gaining ground and which, if consummated, would weaken the position of the American Road Builders Association is the proposed organization of a highway division in the American Society of Civil Engineers. Still another undercurrent is the proposal to revive the defunct American Highway Association, which was abolished a few years ago. It was thought at that time that the American Road Builders Association could be depended on to carry on the work remaining to be done. There is a widespread feeling now that this duty has not been adequately performed.

From what has been said it is clear that the American Road Builders Association must now demonstrate its position of real leadership or else have that position preempted by some new organization or an existing body in reorganized form. The executive control of the national road building association of the United States should be in strong hands, a position which it does not occupy under the present management. At this year's annual convention in Chicago those who had a broad outlook on the organization's possibilities secured the appointment of a nominating committee pledged to progressive principles. That committee's recommendations were defeated at the board of directors' meeting two weeks ago. Indications are that things will run along in the same old way. Under present conditions is it not conceivable that a small group of the leaders in the field will get together and plan some action, either through the American Road Builders Association or another body, which will make association management in the road-building field more nearly representative of the big place in national affairs which that specialty now occupies?

Design, Construction and Use of Metal Flumes

Semi-Circular Flumes Discussed from the Standpoint of Types, Supports, Stresses, Expansion, End Structures and Surface Coverings

By Julian Hinds
Engineer, U. S. Reclamation Service, Denver, Col.

METAL flumes of the non-riveted metal type were erected first in this country in 1902 by Pat Maginnis at Kimball, Neb. The device was later patented and is used extensively at the present time throughout the irrigated portions of the West for carrying water along steep hillsides and across topographic depressions of moderate depth. It is proposed in the present article to discuss the types of flumes from the earliest Maginnis to the latest non-ferrous metal flume, to note the essential features and limiting stresses in the design of the supporting structures and end structures, to give experience of the U. S. Reclamation Service with protective surface coverings and to give some unpublished information on friction losses.

Engineers of the U. S. Reclamation Service have probably had more experience in the design of metal flumes and knowledge of their service than any other group of men. This article, by a Reclamation Service engineer, represents their current knowledge on the subject. It is a most important contribution to irrigation engineering practice.

Essentially the metal flume consists of comparatively light sheets curved to semi-circular form and suspended from cross-beams or stringers by means of hoops or other supporting members. Fig. 1 shows diagrammatically the mechanical principles of the original Maginnis flume. The two overlapping sheets *a* and *b* are held between the rod *c* and the compression bar, or curved channel *d*. By tightening the nuts *e*, the rod *c* is put in tension, the curved channel *d* in compression, and the flume sheets are pressed together. The weight of the flume and its water load is transferred from the rod *c* through the washers *f* and carrier beam *g* to the stringers *h*.

The Maginnis flume presents a rough interior, which reduces the carrying capacity. Considerable effort has been devoted to the development of joints free from this objection, and a number of so-called smooth interior flumes have been designed and patented. A partial list of the types of joint in use at the present time is shown in Fig. 2. In all cases watertightness is secured by the principle first used by Maginnis. In certain types the inside compression bar is omitted, the compression being thrown into the inside sheet. In one type (not shown) both the compression bar and the tension rod are omitted, the inside and outside sheets being used respectively for the compression and tension members.

Each of the several types of joints possesses certain points of superiority and various advantages are claimed by the respective manufacturers. A satisfactory joint should be simple, secure and watertight. It should be easily assembled in the field, should offer as much circumferential rigidity as possible and should offer the least possible resistance to flow. Where galvanized sheets are used the angles at the beads should be made "easy" to avoid injury to the spelter in the forming operation.

Deeply-beaded types offer a maximum resistance to circumferential deflection, but require special sheets on curves and unless carefully manufactured are likely to show injury to the spelter at the joints. Flat or lightly-beaded types are easily erected and require no special work on curves. While such types offer less circumferential rigidity than the more complicated joints, certain of them have been found to be satisfactory for flumes up to 7 or 8 ft. in diameter, and it is claimed that they can be used for even larger sizes.

Standard sizes of flumes are determined by stock lengths of sheets from which they are made, and are designated commercially by "numbers" which are equal to the perimeter of the semi-circle in inches. The sheets may be of any suitable metal, and if of steel or iron, should be galvanized. The proper thickness of sheet to use for a given size of flume is not subject to mathematical computations. The Reclamation Service makes the following requirements as to thickness for steel or iron sheets: Up to No. 48 flume, 22-gage; to No. 96, 20-gage; to No. 132, 18-gage; to No. 168, 16-gage; to No. 204, 14-gage; to No. 252, 12-gage. Where metal of insufficient thickness is used the flume is flimsy, and galvanized sheets are rapidly destroyed by rust after the galvanizing is eroded away. Erosion is rapid where the water carries sand and gravel, especially at high velocities.

A specially rolled zinc sheet recently placed on the market by the Thompson Manufacturing Co., of Denver, under the name of Lastite, is being tested out for use in the manufacture of flumes and culverts. This metal is particularly adapted to flumes of the deeply-beaded types, since it is not subject to damage in the forming operation as is the case with galvanized sheets. Lastite is undoubtedly superior to iron or steel in point of resistance to corrosion, but is somewhat deficient in structural strength. This lack, it is claimed, can be compensated for by a closer spacing of the suspension rods. Several flumes of this metal installed in the vicinity of Denver last season (1921) appear to be entirely satisfactory. Lastite is somewhat higher in first cost than galvanized sheets, but it is expected that it will show a much longer life and that it will not require painting.

Supporting Structures—Trestles and trusses for supporting the stringers may be of timber or steel. Information for use in the design of trestles will be found in catalogs furnished by flume manufacturers. Knee-braces are usually used on trestles to give longitudinal stiffness and to reduce the effective length of stringer span. When used for the latter purpose they should

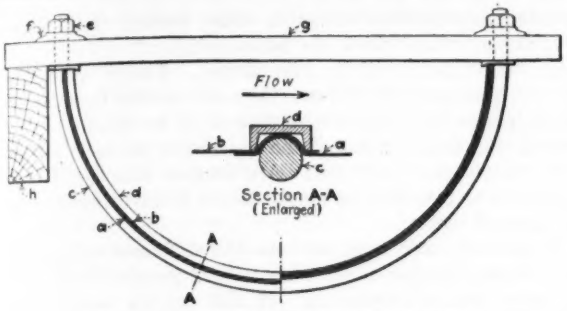


FIG. 1. ORIGINAL MAGINNIS FLUME

be of ample size and should be securely supported. If the stringer reactions are figured for a beam continuous over four supports it will be found that the knee-braces carry practically the entire span load. If the braces fail the stringers act as simple beams between the posts. Unequal settlement of foundation is likely seriously to affect stringer and knee-brace loads, and where settlement is likely to occur suitable allowance should be made. If stringers that are too small are used the heavy deflection opens the flume joints causing leakage.

The posts should be designed as columns to carry the maximum water and wind loads coming upon them. The lower end of the posts are usually anchored to concrete pedestals, which should have a sufficient weight to prevent the overturning of the empty flume by wind pressure, and sufficient base area to prevent undue settlement. In cold climates the alignment of the flume is likely to be disturbed by unequal frost action upon the pedestals. Trouble from this cause may be avoided by carrying the pedestals below the frost line. Where the pedestals are set in alkali soils proper measures should be taken to prevent deterioration of the concrete. Piles are sometimes used where foundation conditions are bad. The piles may be cut off near the ground and used as supports for framed bents, or they may support the flume directly.

Bridge Supports—Fig. 3 shows a No. 192 flume supported underneath the floor of a steel-truss highway bridge near Worland, Wyo. Fig. 4 is a twin flume

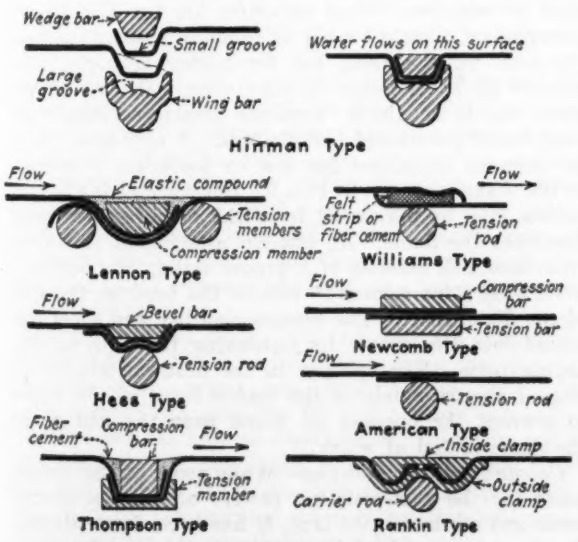


FIG. 2. VARIOUS FLUME JOINT DETAILS

erected by the U. S. Reclamation Service to carry the Garfield canal across the Rio Grande near Dona Ana, N. M. Each barrel of this flume is 8 ft. 3½ in. in diameter (No. 156) and the flume is carried on a three-truss suspended-span cantilever steel bridge. A cross-section of the flume and bridge is shown in Fig. 5, and expansion-joint details between the fixed and suspended spans are shown in Fig. 6. The uniform flume load is admirably adapted to the continuous bridge, but at this location the foundation was poor and unequal settlement was anticipated. The trusses were therefore articulated in alternate spans approximately at points of contraflecture to give the necessary flexibility. For large flumes this construction results in marked economy of materials, but where the loads are light the design is governed principally by minimum sizes of members, and the saving is not great. One

FIG. 3. FLUME UNDER HIGHWAY BRIDGE FLOOR.

barrel of larger size would have been more economical, both in cost of flume and of bridge, than the two No. 156 barrels used for the Garfield crossing, but the head room required for the larger flume was not available.

In calculating wind stresses it is usually considered conservative to assume the maximum pressure as acting upon twice the vertical projection of the trestle or truss (exclusive of stringers) plus one and one-third times the vertical projections of the flume. In long-span bridges for single-barreled flumes the wind stresses are usually high, due to shallow horizontal trusses, and it is often necessary to make the bridge wider than is otherwise required, to prevent an objectionable reversal of stresses in the chords under adverse wind conditions.

Flume Deformation—There is a tendency for the flume, when loaded, to depart from the circular form. If perfectly flexible and unrestrained, the loaded portion of the section would assume the form of an hydrostatic catenary supported between the two tangential ends above the water surface, the shape varying with the depth of water in the flume. The stiffness of the metal partially suppresses the distortion and the flume actually assumes a shape between the circle and the catenary. Measurements made upon a number of flumes in service gave the results shown in Fig. 7. In designing supports all cross-bracing should be placed to clear the flume in its distorted form.

It is often necessary to construct a flume on curved alignment. The necessary curvature is secured by introducing slight angles at all or part of the joints between sheets. Interlocked joints, like the Lennon or Hess, require the sheets to be mitered properly in the shop before being rolled. The Williams and other similar types requires no special forming. The angle at any one joint should be made as small as possible. The U. S. Reclamation Service specifies a maximum of 4 deg. for the angle between any two adjacent sheets. Stringers on curves should be spaced to provide the additional clearance required.

Special attention should be given to the design of the carrier beams, rods, washers and shoes. In cinching up the bands to stop leakage stresses considerably in excess of the stresses due to the water load may be produced. For this reason the U. S. Reclamation Service has adopted a working stress in the carrier rods of 8,000 lb. per sq.in. The washers and shoes should be made proportionately strong. The necessary size of washer will depend upon the timber in the carrier beams. The ultimate tensile strength of steel is roughly 75 times the ultimate bearing strength of timber, and the diameter of the washer should accordingly be about 9 times the diameter of the carrier rod. Such a size is impracticable. A washer 6 times the diameter of the rod will give a working stress of 220 lb. per sq.in. bearing when the rod is carrying 8,000 lb. per sq.in. and may be accepted as a conservative standard. Standard size cast-iron or malleable washers have been found to be inadequate. If standard washers are used they should be one or two sizes larger than the rod, to give the area required. The shoes should be of approximately the same area as the washers and should be designed properly to distribute the thrust from the compression bar. The carrier beams should be of ample size to support the flume and water loads, and large enough to resist the warping action of the sun.

Manufacturers recommend the use of metal flumes set directly in the ground for ditch lining. The writer is not in possession of sufficient data to be able to make a statement as to the durability of the metal sheets in such installations. The flume lining, being low in first cost, readily available and easily transported and erected, is doubtless desirable under certain conditions, but on important work the substitution of concrete lining should be carefully considered. Flume used for lining is assembled with carrier rods, carrier beams and compression bars, as when supported on trestle. The stringers are omitted and the assembled flume is set in the trench and backfilled. Anchorages are sometimes required to prevent the empty flume from being floated by ground water.

Expansion and Contraction—Metal flumes supported on timber trestles require no special provision for expansion and construction. If the carrier beams are spiked to the stringers a small movement will occur at each joint, sufficient to care for variation in length due to temperature changes. Where the flume is carried on long steel spans the concentration of movement at the expansion ends of the span may require a special joint in the flume barrel. A common type of joint is illustrated in Fig. 8.

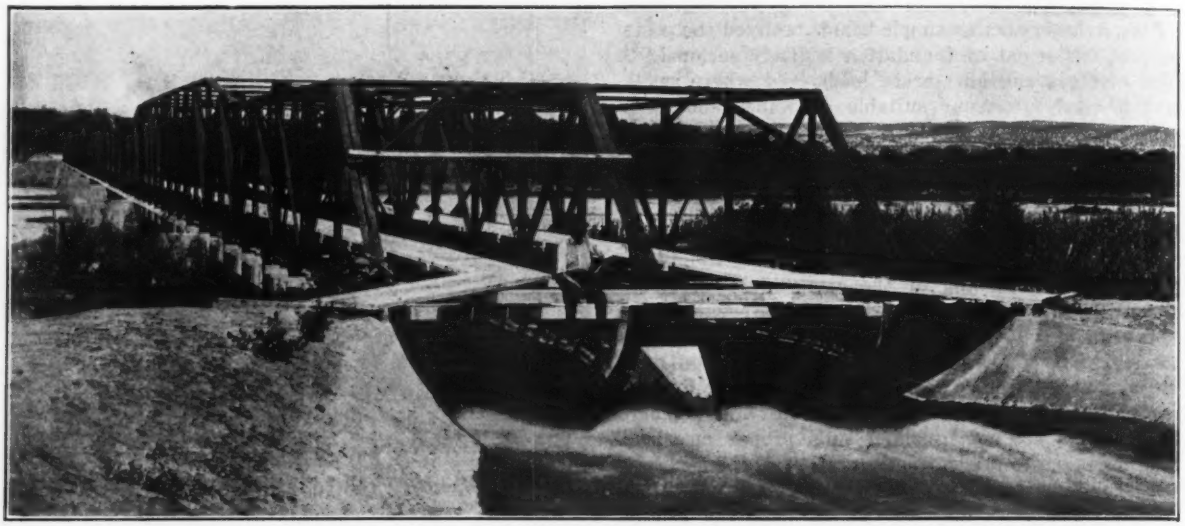


FIG. 4. TWIN FLUMES ON SUSPENDED-SPAN CANTILEVER TRUSSES OVER RIO GRANDE IN NEW MEXICO

End Structures and Sluices—The end structures, which join the flume to the canal, may be of timber, steel or concrete. When velocities are low and losses unimportant a plain timber or concrete headwall across the canal may be used, but for higher velocities and smaller allowable losses of head more elaborate structures will be required. Concrete structures should be used for all permanent installations. A very good form of concrete transition for low or moderate velocities in the flume is shown in Fig. 9. Sheet-metal inlets and outlets may be purchased from the manufacturer who furnishes the flume. An efficient attachment to a concrete headwall consists of a groove left in the concrete filled with a tar cement to receive the bead on the end of the flume sheet. The compression bar and sheet are forced into the groove by tightening the nuts on the anchor bolts. The opening in the headwall should be shaped approximately to the loaded form of the flume to prevent the opening of joints near the end when the flume is full of water.

Galvanizing and Painting—While some of the claims made for the rust-resisting powers of various special irons and steels may be true, it has been demonstrated that in an unprotected form, thin sheets of such metals are not suitable for use in flume construction. It is

imperative that all steel or iron sheets be galvanized, and the life of the flume will be prolonged if the rods, compression bars, shoes and washers are also galvanized. Where black rods are used it is claimed that a part of the zinc is transferred by galvanic action to the rods, weakening the galvanizing near the joints and allowing the sheets to corrode.

The galvanizing of the sheets should be done by the hot process and should consist of a uniform coating of commercially pure zinc, applied in such a manner that it will adhere firmly to the metal and be free from

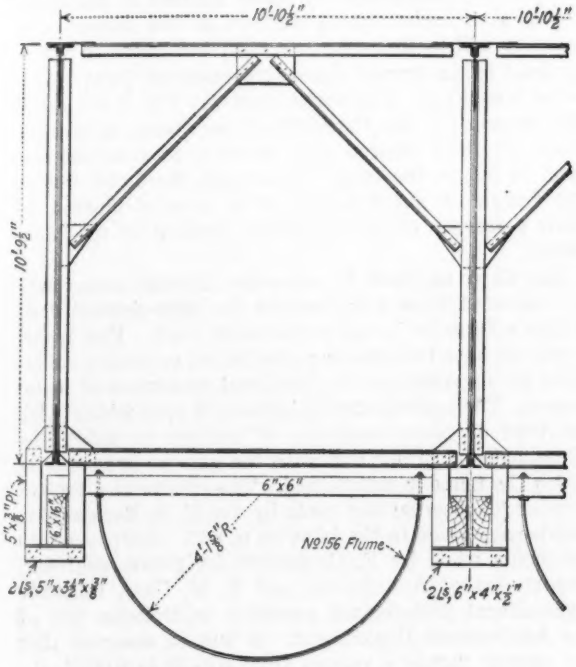


FIG. 5. CROSS-SECTION THROUGH MAIN TRUSS OF GARFIELD FLUME AND BRIDGE

abrasions, blisters, cracks, sal ammoniac spots and other injurious imperfections. The effectiveness of the galvanizing will be greatly increased if each square foot of sheet is given 2 oz. of zinc, instead of the customary 1½ oz. No sheet showing imperfections or injury to the galvanizing where the surface will be exposed to the water should be used. All breaks in the galvanizing, where not exposed to the water, should be repaired with solder or other suitable coating, without the use of acids injurious to the spelter, and in such manner as to leave the surface free from abrasions that might prevent a tight joint. Carrier rods, compression bars, shoes, nuts and washers should have a galvanized coating of not less than ½ oz. of chemically pure, or ¾ oz. of commercially pure zinc for each square foot of surface area.

In some localities galvanizing is a sufficient protection for metal parts, but it is sometimes found that due to chemicals in the water and abrasion from sand and gravel carried in suspension the zinc coating is rapidly destroyed and the iron or steel base is exposed to rapid deterioration. In such cases it becomes necessary to paint the inside of the flume. The service requirements for a paint for this purpose are very exacting, and most ordinary paints are practically valueless.

Some years ago the U. S. Reclamation Service conducted a set of tests to determine, if possible, the paint best suited for this work. The experiments were conducted under service conditions in widely separated localities and by different engineers. Tar paint was found to be superior to any other paint tried. The only other paint that made a creditable showing was a bitumastic compound of unknown composition. A number of paints with asphaltic base, recently put on the market, give promise of satisfactory performance, and the use of a small percentage of cement in coal tar is claimed to give excellent results. The cement is said to neutralize acid in the tar and to give body to the paint, rendering it less likely to run in summer.

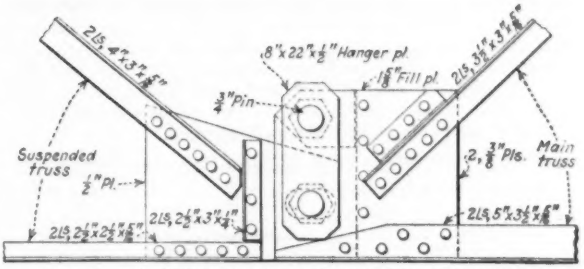


FIG. 6. EXPANSION JOINT BETWEEN SUSPENDED AND CANTILEVER SPANS

In a recent report on inspection of flumes, Uncompahgre Project, Colorado (*Reclamation Record*, November, 1920, p. 521), F. D. Pyle, formerly project manager of that project, comments upon the painting of the flumes inspected as follows:

Of the 69 flumes, 59 have received a coat of tar or paint on the interior in order to protect them against rust and erosion. The first tar was used in 1913, but proved to be too brittle and lifeless. In the spring of 1916 various kinds of paint were tried without success. Later several paint companies furnished small lots of paint to make tests. In no case have these paints proved equal to the coal tar placed during the past 3 years.

In the fall of 1917 and spring of 1918 a number of flumes were treated by applying a coat of water-gas tar followed by a coat of coal tar thinned with water-gas tar. This made considerable extra work, and in a number of cases the coating was too thin, either running to the bottom of the flume or checking and cracking on the side of the flume exposed to the sun. Since the summer of 1918 coal tar has been used without thinning, with very good results. The best results have been obtained when tar was applied before the flume had been used more than one season and when tar was applied in warm weather. When applied in cold weather it would not stick to the metal, but blistered and peeled. In tarring flumes it was found essential to clean the surfaces thoroughly, removing all rust from the sheets and from the joints, and to have them perfectly dry and free from dust. The tar was applied hot with heavy brushes or burlap swabs.

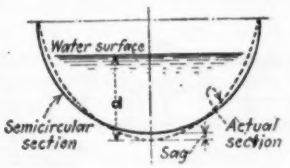


FIG. 7. SAG IN METAL FLUMES

Size	Type	Dia.	d	Sag
*108	Hinman	5.730	1.96	0.10
108	Hinman	5.730	1.11	0.10
108	Hinman	5.730	1.87	0.12
108	Hinman	5.730	1.22	0.13
156	Hinman	8.276	2.72	0.17
156	Hinman	8.276	2.50	0.20
156	Hinman	8.276	2.35	0.20
156	Hinman	8.276	2.30	0.21
156	Hinman	8.276	2.00	0.20
156	Hinman	8.276	2.68	0.21
156	Hinman	8.276	2.52	0.23
156	Hinman	8.276	2.43	0.27
156	Hinman	8.276	2.28	0.15
156	Hinman	8.276	2.07	0.22
132	Hinman	7.003	1.69	0.05
132	Hinman	7.003	1.55	0.08
132	Hinman	7.003	1.98	0.06
132	Hinman	7.003	1.96	0.12
132	Hinman	7.003	2.23	0.08
132	Hinman	7.003	2.00	0.08
*120	Hinman	6.366	1.90	0.06
120	Hinman	6.366	1.45	0.15
120	Hinman	6.366	2.46	0.18
120	Hinman	6.366	1.88	0.18
204	Hess	10.823	3.08	0.35
204	Hess	10.823	2.90	0.35
204	Hess	10.823	3.12	0.34
204	Hess	10.823	3.06	0.34

Conditions indicate that the joints should be retarred every fall, and the entire flume every other fall. The tar coat fails by drying, checking, peeling and blistering. In some cases there is a tendency to erode from the bottom especially where gravel is carried by the water. A heavy coating of coal tar has proved to be the best method of protecting the flumes when properly applied.

Mr. Pyle's findings are substantially corroborated by other experimenters except as to his objection to a priming coat of water-gas tar. The life of the flume barrel will be largely determined by the diligence with which the painting is maintained.

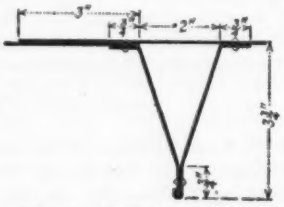


FIG. 8. EXPANSION JOINT FOR NO. 108 FLUME

It is not possible at the present time to make an authoritative statement as to the life of metal flumes, due principally to the comparatively short time they have been in general use. It is believed that a life of from 15 to 20 years may be reasonably expected for galvanized sheets, and under favorable conditions this period may be considerably extended. Lastite sheets or other non-rusting metal should have a longer life.

The painting of timber or metal supports should conform to standard practice for similar structures in the same locality. The same tar paint used on the flume is an excellent preservative for metal work. The life of timber may be prolonged by creosote treatment.

Hydraulics—Sufficient fall must be provided at the intake and throughout the flume to produce the necessary increase in velocity and to overcome transition losses and friction. With the type of inlet structure shown in Fig. 9, the drop at the entrance may be taken as 1.1 times the increase in velocity head. With a more abrupt transition a greater drop will occur, ranging possibly up to 1.5 times the change in velocity head for a plain headwall. Where velocities are high the head saved by a well-designed inlet structure is considerable. In addition to conserving head an efficient inlet structure tends to produce smoother flow in the flume, due to the elimination of contractions at the entrance. Long flumes with limited falls should always be provided with good inlets. Where the flume is short it may be economical to use a simple inlet structure and to increase the size of the flume to compensate for the simpler design.

At the outlet a part of the drop in velocity head, due to reduction of the velocity, is recovered, and under ordinary circumstances the water surface in the canal stands at a higher elevation than in the flume. The recovery will be less than the total decrement in velocity head by an amount depending upon the form of the outlet transition. The outlet shown in Fig. 9 will probably recover not less than 0.75 of the change in velocity head. If it is desired this recovery may be counted upon to reduce the total fall through the flume, but in the design of small flumes it is usually ignored to allow a margin of safety against fouling of the canal below.

The slope required to overcome friction losses may be computed from any formula for open-channel flow. Kutter's formula is quite commonly used. Few measurements have been made under actual operating conditions for determining the frictional resistance of metal flumes. The coefficient of friction will vary widely with the type of joint, condition of surface or paint, the alignment and profile and with the general condition in which the flume is maintained. The results of a limited number of observations made by the U. S. Reclamation Service are given in the table on p. 860. Additional experiments made by F. C. Scobey, irrigation engineer, Department of Agriculture, and V. M. Cone, Colorado Agricultural College, are recorded in Bulletin 194 of the Agricultural Department. It will be observed that for smooth flumes n ranges from 0.0139 to 0.0097, the average value for twenty-one experiments being 0.0114. For the Maginnis type the average is 0.0185, and for the Newcomb, 0.0128. A value of $n = 0.012$ is believed to be conservative for smooth interior flumes on tangent or easy curves properly maintained. On badly-curved or poorly-maintained alignment n should be taken as 0.013 for smooth interior flumes. It has been claimed that poorly-applied paint increases the value of n. Care should be taken to see that the paint as applied leaves a smooth surface, as free as possible from sags and runs.

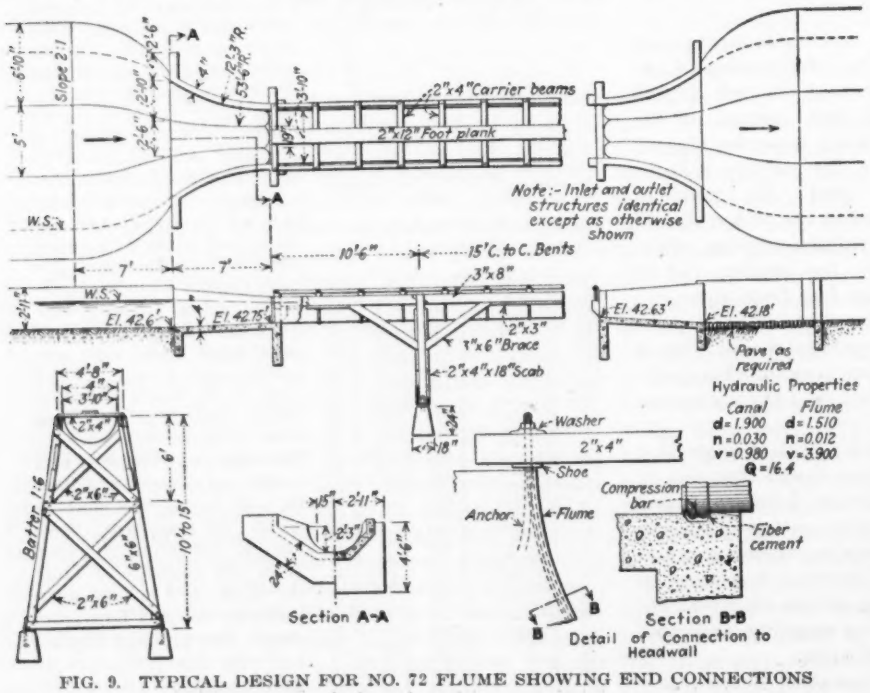


FIG. 9. TYPICAL DESIGN FOR NO. 72 FLUME SHOWING END CONNECTIONS

The selection of the proper size of flume for a given set of conditions is greatly facilitated by the diagram, Fig. 10. Let it be required to select a flume to carry 120 sec.-ft. on a slope of 0.001, with $n = 0.012$.

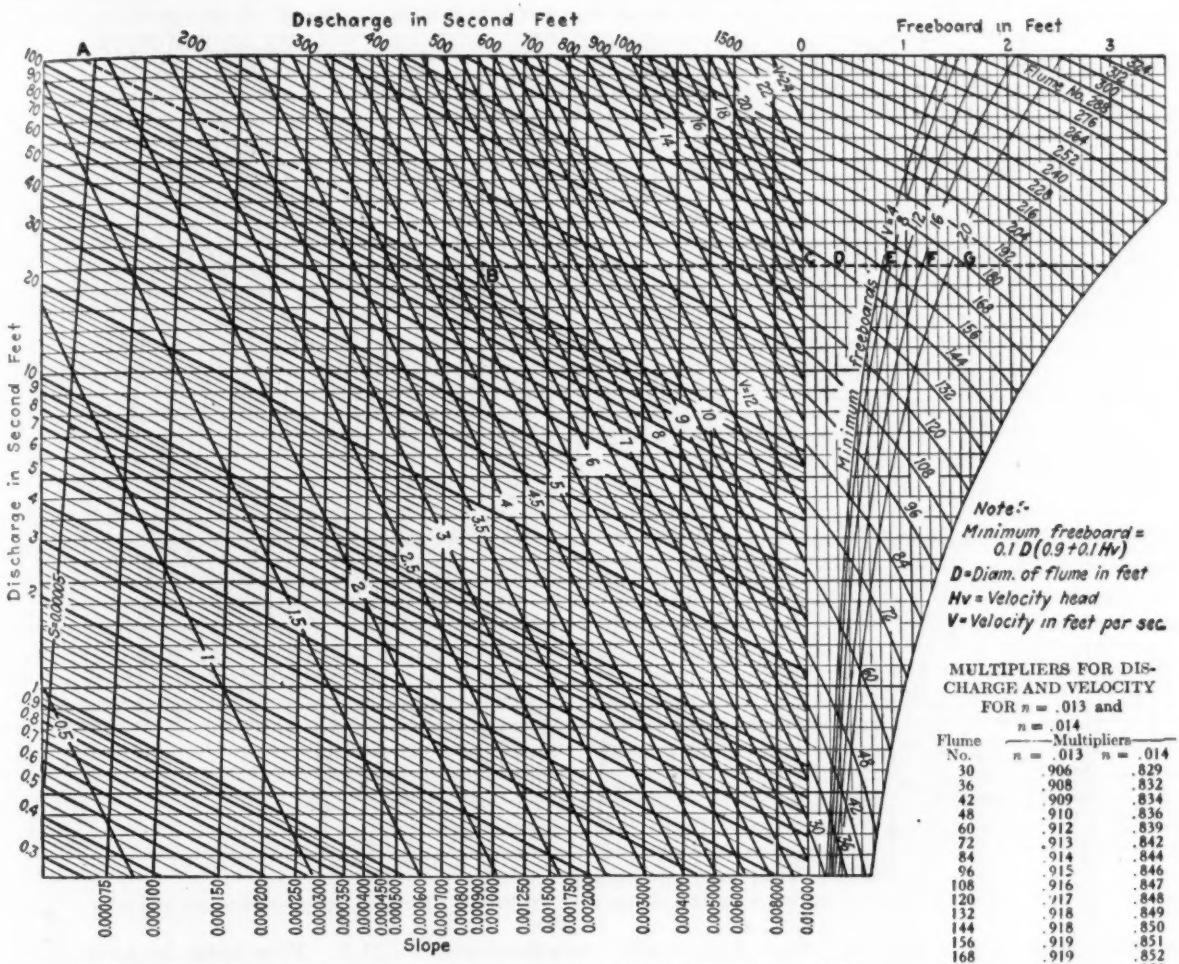


FIG. 10. DISCHARGE DIAGRAM FOR SEMI-CIRCULAR FLUMES WITH $n = 0.012$

MULTIPLIERS FOR DISCHARGE AND VELOCITY FOR $n = .013$ and $n = .014$

Flume No.	Multipliers $n = .013$	Multipliers $n = .014$
30	.906	.829
36	.908	.832
42	.909	.834
48	.910	.836
60	.912	.839
72	.913	.842
84	.914	.844
96	.915	.846
108	.916	.847
120	.917	.848
132	.918	.849
144	.918	.850
156	.919	.851
168	.919	.852
180	.919	.853
192	.920	.853
204	.920	.354
216	.920	.855
228	.921	.855
240	.921	.856
252	.921	.857
264	.921	.857
276	.922	.858
288	.922	.859
300	.922	.859
312	.922	.860
324	.923	.860

Enter the diagram at *A*, with the required discharge and pass diagonally downward to the right to intersect the given slope at *B*, and note the approximate velocity. Passing horizontally to the right from *B*, the required size of flume (fractional in this case) flowing full is found at *C*. Passing still farther to the right through the point *D*, *E*, *F*, *G*, etc., it is found that the given discharge may be carried by a No. 144 flume with a freeboard of 0.3 ft., a No. 156 flume with a freeboard of 0.75 ft., a No. 168 flume with a freeboard of 1.2 ft., and so on. The smallest flume that will carry the discharge with a safe freeboard should be selected.

The freeboard should be sufficient to provide for the passage of floating matter under the cross-beams and to allow for decrease in carrying capacity due to improper maintenance. It should also provide a margin of safety against slopping over. The standard freeboard lines on the diagram are platted from the U. S. Reclamation Service standard equation for freeboard in metal flumes, which is given in the notes accompanying the figure. In the example under consideration the correct size of flume is found at *E*, where the velocity corresponds approximately to that noted at *B*

The diagram is general, except as to value of *n*, and procedure for conditions other than those illustrated will suggest themselves. The flume-number lines in the right-hand part of the diagram are not platted for freeboards greater than one-half the depth of the flume, but may be extended down to zero depth if desired. Freeboards are used in preference to depths for convenience. Velocities taken from the left-hand diagram are exact for a freeboard of 0.1 of the diameter, but are approximate for other freeboards. All other quantities are exact within the accuracy of the diagram. Theoretically the flume-number lines in the right-hand part of the diagram, if platted to cover all combinations of discharge and slope, are bands of measurable widths rather than true lines, since with Kutter's formula sections of dissimilar shape equivalent on one slope are not equivalent on another. It is found by trial, however, that the width of band is small, and can only be detected by carrying computations to an accuracy beyond the scope of published tables and diagrams for Kutter's formula. The unavoidable mechanical inaccuracies of the diagram overbalance the theoretical errors, and the diagram is exact within its limits. The velocities given are sufficiently accurate for use in determining the freeboard. If great accuracy is required, the velocity may be obtained by dividing the discharge by the area.

A table of multipliers is given in Fig. 10, to be used

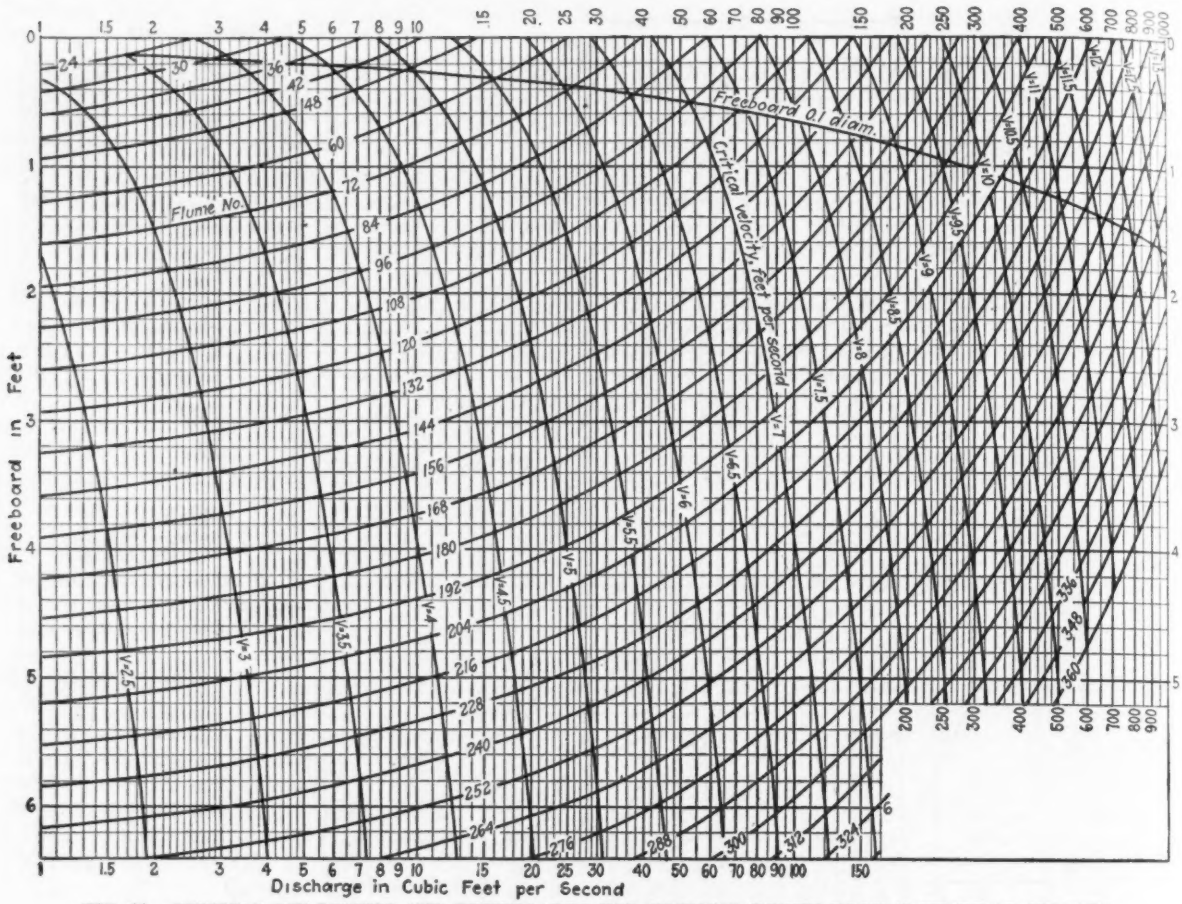


FIG. 11. CRITICAL VELOCITIES AND FREEBOARDS FOR CRITICAL DEPTH IN SEMI-CIRCULAR FLUMES

where the value of n is 0.013 or 0.014. The velocity and discharge taken from the diagram should be multiplied by the proper coefficient from the table to get the correct values for the higher friction coefficient. These multipliers are accurate for a freeboard of one-twelfth the diameter of the flume, and are close for other reasonable freeboards. They are extended from Table I of a paper on the "Discharge Capacity of Semi-Circular Steel Flumes," by E. A. Moritz, *Engineering News*, Jan. 22, 1914, p. 192.

Influence of the Critical Depth—The semi-circular flume is especially susceptible to the influence of the critical depth and the hydraulic jump. A typical example of the fluctuations resulting from flow at approximately the critical depth is given in the *Engineering News-Record* for Jan. 3, 1918, p. 38, in an abstract from the *Reclamation Record* of a paper by J. S. Longwell on "Flow Conditions, Congo Low-Line Flume, North Platte Project." A theoretical discussion, by the writer, of the "Hydraulic Jump and Critical Depth in the Design of Hydraulic Structures" will be found in the *Engineering News-Record*, Nov. 25, 1920, p. 1034.

The diagram, Fig. 11, has been prepared for the determination of the critical depth in semi-circular channels. Suppose that it is found in a given case that with the available fall a No. 168 flume with a freeboard of 1.10 ft. will be required to carry 200 sec.-ft. Following the 200-sec.-ft. line in Fig. 11 down to the No. 168 flume it is found that the critical depth corresponds to a freeboard of 1.01 ft. Flow under the given conditions will, therefore, be only slightly below critical, and

EXPERIMENTAL VALUES OF KUTTER'S n IN SEMI-CIRCULAR FLUMES

Test No.	Project	Location	Length Tested in Ft.	Size of Flume	Discharge Sec.-Ft.	Vel.	n
		Lennon Type					
1	N. Platte	Hope Creek	300	204	105	5.91	0.0123
2	N. Platte	Hope Creek	300	204	99	5.56	0.0130
3	N. Platte	Hope Creek	300	204	150	5.91	0.0129
4	N. Platte	Wild Horse	600	156	78	6.46	0.0107
5	N. Platte	Wild Horse	600	156	95	7.00	0.0105
6	N. Platte	Wild Horse	600	156	64	5.98	0.0101
7	N. Platte	Wild Horse	600	156	68	5.96	0.0106
8	N. Platte	Wild Horse	600	156	44	4.77	0.0121
9	N. Platte	West Water	400	132	56	6.83	0.0087
10	N. Platte	West Water	400	132	45	5.11	0.0105
11	N. Platte	Red Willow	690	120	40	4.37	0.0117
12	N. Platte	Red Willow	690	120	18	3.00	0.0121
13	N. Platte	Middle Creek	525	108	39	5.74	0.0097
14	N. Platte	Middle Creek	525	108	14.5	4.29	0.0097
		Smooth Type					
15	Uncompahgre	King Lateral	197*	120	62.5	8.04	0.0122
16	Uncompahgre	Happy Canyon	350*	192	36.5	2.40	0.0117
17	Uncompahgre	Spring Creek	300†	168	20.8	2.04	0.0139
18	Uncompahgre	Happy Canyon	250	204	177	6.23	0.0131
19	Uncompahgre	Happy Canyon	250	204	184	6.30	0.0121
20	Uncompahgre	Happy Canyon	230	204	127	5.06	0.0125
21	Uncompahgre	Happy Canyon	220	204	73.9	4.17	0.0103
		Maginnis Type					
22	Uncompahgre	King Lateral	140*	108	42.1	4.85	0.0175
23	N. Platte	Lat. 21-M	590	132	38.5	3.91	0.0188
24	N. Platte	Lat. 21-M	590	132	23.0	3.34	0.0178
25	N. Platte	Lat. 21-M	590	132	17.0	2.98	0.0180
26	N. Platte	Lat. 21-M	490	132	75.8	4.53	0.0202
		Newcomb Type					
27	Huntley		100	108	15.26	2.39	0.0135
28	Huntley		100	108	15.26	2.22	0.0133
29	Huntley		100	108	15.26	2.10	0.0129
30	Huntley		100	108	15.26	2.015	0.0123
31	Huntley		100	108	15.26	1.83	0.0130
32	Huntley		100	108	15.26	1.755	0.0123
33	Huntley		100	108	15.26	1.625	0.0128
34	Huntley		100	108	15.26	1.505	0.0130
35	Huntley		100	108	15.26	1.475	0.0122

* Tangent. † Tangent and curves.

objectionable fluctuations are likely to result. If the slope cannot be changed, a larger flume should be used to provide a greater freeboard.

Where flow in the flume is below the critical depth, special consideration must be given to the inlet and outlet structures. A discussion of the design of transition for this condition will be found in the paper above referred to on the hydraulic jump and the critical depth.

Costs—It is difficult at the present time to predict in advance the cost of any class of construction work, and estimates, even of a comparative nature, should be based upon actual quotations wherever possible. In general a metal flume will cost less for first installation than a concrete siphon or concrete flume, but comparison with wood flume or wood-stave or light-steel pipe will depend upon local conditions. In making any cost comparison due consideration should be given to maintenance and replacement costs.

Roughly, the cost of erecting the metal work of the flume barrel will amount to about 10 per cent of the purchase price. Freight and hauling should be added. The cost of erecting flume trestles is comparatively high. For small and medium-sized flumes the cost of furnishing bolts and nails and erecting structures will be approximately equal to the cost of the timber. The cost of the concrete pedestals should be figured separately. The field cost of the metal work in place, as constructed by the U. S. Reclamation Service in 1919 and 1920 was from 15c. to 20c. per pound.

Motor Vehicle Registration and Revenue in 1921

THE U. S. Bureau of Public Roads has issued the figures given in the accompanying table covering the registration of motor vehicles in the United States and the revenue received from them during the year 1921. The total passenger-car and motor-truck registration was 10,465,995 and the total revenue from registration and license fees was $122,478,654. Gasoline taxes in 12 states contributed an additional revenue of $4,968,971.

Of the total vehicles registered 9,432,844 were passengers cars, 982,604 were motor trucks and commercial cars, and 50,547 were taxicabs and buses.

TABLE I—MOTOR VEHICLE REGISTRATIONS AND REVENUES FOR THE YEAR 1921.

State	Total Car And Truck Registration	Passenger Cars	Trucks and Commerical Cars	Taxis and Buses	Trailers	Motor Cycles	Total Gross Motor Vehicle Registration And license Revenues	Gross Revenues From Gasoline Tax	Motor-vehicle Revenue Available for Road Work By or Under State Highway Department	Under Direction of Local Authorities
Alabama	82,366	69,422	9,110	3,834	.....	810	$1,147,265	.....	$917,812	.....
Arizona	35,611	31,069	3,980	562	.....	440	195,970	$87,928	195,970	.....
Arkansas	67,408	66,480	928*b*	.....	4	174	856,544	170,000*c*	256,963	$599,581
California	680,614	645,522	35,092	.....	.....	17,729	6,834,090	.....	3,018,192	3,018,192
Colorado	145,739	136,336	9,403	.....	45	2,868	906,059	559,472	410,158	410,158
Connecticut	134,141	108,692	24,112	1,337	.....	5,282	2,129,861	176,489*g*	2,129,861	.....
Delaware	21,413	21,413*a*	.....	.....	67	541	375,469	.....	375,469*c*	.....
Dist. of Col.	40,625*d*	33,654	5,177	1,794	.....	1,101	209,583	.....	.....	.....
Florida	97,957	83,111	14,846	.....	.....	1,296	734,845	283,86..	570,402	.....
Georgia	131,976	131,976*a*	.....	.....	.....	1,232	1,705,941	302,158*f*	1,705,941	.....
Idaho	51,294	46,935	4,359	.....	.....	744	841,213	.....	210,303	630,910
Illinois	663,348	583,441	79,907	.....	.....	8,898	6,803,556	.....	6,776,781*c*	.....
Indiana	400,342	357,025	43,317	.....	1,851	7,524	2,422,227	.....	2,281,276	.....
Iowa	461,084	430,118	30,966	.....	344	3,897	7,719,127	.....	7,217,384*h*	.....
Kansas (i)	289,539	267,891	21,648	.....	.....	2,271	1,400,000	.....	1,400,000	.....
Kentucky	126,802	110,602	15,025	1,175	.....	.....	1,771,887	411,939	1,771,887	.....
Louisiana	77,885	67,311	10,574	.....	.....	479	453,276	.....	453,276	.....
Maine	77,527	67,591	9,936	.....	.....	1,525	1,004,750	.....	496,461*k*	.....
Maryland	136,249	120,231*l*	11,597*m*	4,421	.....	5,271	2,460,162	.....	1,750,000	.....
Massachusetts	360,732	305,471	55,261	.....	472	12,048	4,717,389	.....	4,717,389*n*	.....
Michigan	476,452	426,687	49,765	.....	4,330	6,195	6,751,925	.....	3,135,040	3,126,456
Minnesota	323,475*o*	299,100	24,375	.....	820	3,150	5,672,425	.....	5,672,425	.....
Mississippi	65,039	65,039*a*	.....	.....	.....	.....	751,947	.....	649,345	.....
Missouri	346,437	346,437*a*	.....	.....	.....	3,609	2,505,354	.....	2,505,354	.....
Montana	58,785	58,785*a*	.....	.....	.....	472	594,520	228,799*e*	274,017	274,017
Nebraska	238,704	219,781	18,923*p*	.....	322	1,866	2,824,811	.....	2,116,747	705,582
Nevada	10,821	10,000*q*	821	.....	.....	131	102,800	.....	97,200	600
New Hampshire	42,039	36,994	5,045	.....	.....	2,358	876,322	.....	790,129	.....
New Jersey	272,994	248,477	24,517	.....	857	9,724	3,974,064	.....	3,733,686	.....
New Mexico	22,559	21,155	1,404	.....	.....	152	198,633	*xx*	194,052	.....
New York (r)	812,031	630,791	148,553	32,687	3,213	26,998	10,288,858	.....	7,716,644	2,572,215
N. Carolina (i)	148,627	134,884	13,743	.....	.....	1,274	2,259,240	506,019*s*	2,259,240	.....
N. Dakota	92,644	90,221	2,423	.....	.....	811	683,052	.....	201,526	201,526
Ohio	720,634*t*	622,044	98,590	.....	4,801	17,203	6,894,160	.....	3,250,125	3,456,355
Oklahoma	221,300	221,300*a*	.....	.....	.....	1,013	2,619,714	.....	.....	2,354,549
Oregon	118,198	103,735	14,360*u*	103	290	3,164	2,334,931	935,126	1,665,000	555,000
Pennsylvania	689,589	632,541	57,048	.....	951	21,111	9,470,174	835,326*g*	9,470,174	.....
Rhode Island	54,608	43,662	9,693	1,253	41	1,751	848,724	.....	764,483	.....
S. Carolina	89,836	82,993	6,843	.....	59	.....	741,115	.....	587,056	.....
S. Dakota	119,274	110,997	8,277	.....	.....	.....	720,587	.....	.....	648,528
Tennessee	117,025	102,795	14,230	.....	.....	1,043	1,387,870	.....	661,655	661,655
Texas	467,616	467,616*a*	.....	.....	.....	3,905	3,806,395	.....	1,865,080	1,852,562
Utah	50,185	40,562	9,623	.....	.....	909	441,360	.....	432,960	.....
Vermont	37,265	33,778*a*	3,487	.....	.....	965	668,288	.....	618,288	.....
Virginia	139,200	122,000	17,200	.....	.....	2,100	2,021,146	.....	1,970,703	.....
Washington	185,359	154,239	27,739*w*	3,381	797	3,913	3,140,731	471,848	2,800,031	.....
West Virginia	93,940	77,397	16,543	.....	.....	1,539	1,250,526	.....	1,250,526	.....
Wisconsin	341,841	320,577	21,264	.....	.....	6,423	3,671,645	.....	2,568,109	856,036
Wyoming	26,866	23,966	2,900	.....	.....	322	288,122	.....	288,122	.....
Totals	10,465,995	9,432,844	982,604	50,547	22,685	197,418	122,478,654	$4,968,971	$94,193,244	$21,923,924

a. Includes motor truck regitstrations.
b. Trucks registered since May 1, others included under passenger cars.
c. To pay interest and principal on State highway bonds.
d. Does not include 8,439 non-resident passenger cars and 1,023 non-resident trucks.
e. For period May-December inclusive.
f. For period August 10 to December 31 inclusive.
g. For period September-December inclusive.
h. To State primary road fund.
i. For period July-December inclusive.
j. Devoted to State Aid and special road drag funds.
k. Does not include about $500,000 used to pay interest and principal on State Highway bonds.
l. Includes approximately 12,000 non-resident passenger cars.
m. Includes approximately 2,000 non-resident trucks.
n. Devoted to road work in accordance with appropriations by Legislature.
o. Does not include 1,752 cars and trucks owned by State, cities and counties.
p. Includes motor bus registrations.
q. Does not include 179 cars owned by State and cities.
r. 11 months, February-December inclusive.
s. Period March-December inclusive.
t. Does not include 2,800 cars and trucks owned by State, cities and counties.
u. Includes 5,223 commercial vehicles of less than 1 ton cap.
v. Does not include 490 cars and trucks owned by State and cities.
w. Does not include 1891 State vehicles.
x. Period June 20-December inclusive.
xx. Amount to be collected now before courts for determination.

FROM JOB AND OFFICE

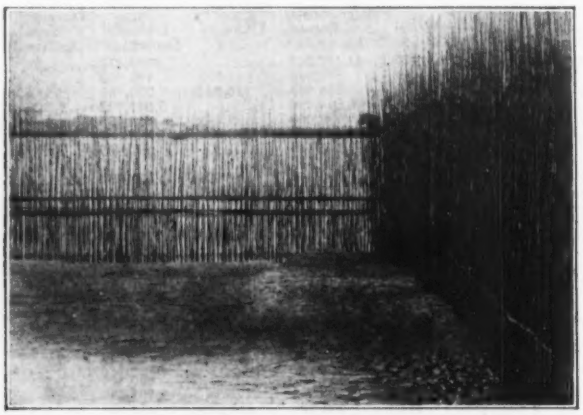
Hints That Cut Costs and Time *For Contractor and Average Engineer*

Bamboo Dikes Aid Land Reclamation and River-Channel Control in China

LAND reclamation by permeable dikes which cause accretion is practiced by the Chinese on some of their shifting rivers which carry large quantities of sand and silt during freshets. These dikes are built by working sharpened bamboo stalks into the sand or mud of the river bed, the stalks being from 6 to 12 in. apart.

The bamboo used varies from 5-ft. tips no larger than a man's little finger to stalks 1¾ in. in diameter and 20 ft. long. If the current is not too strong the larger bamboo can be planted in water as deep as 10 ft., but most of the native work is done in shallow water. In the vicinity of Foochow, these dikes are from 6 to 12 ft. wide, of lengths up to several thousand feet, and are generally placed with the direction of the current.

In one or two seasons such a dike will cause the formation of a long sandbank with the surface well above low-water level. In the tidal portion of the



BAMBOO DIKE IN MIN RIVER, CHINA

river as soon as the sandbank gets above half-tide level a coarse grass will take root. The natives encourage this growth by planting the grass in tufts 5 or 6 ft. apart. It then spreads rapidly and by collecting the silt from the water that flows over it at every tide, it gradually builds up an island, unless the river in one of its frequent changes of channel washes the island away. Formation of new land is encouraged along the convex side of a channel by bamboo spur dikes. To protect an eroding river bank a dike may be built in such a position above the point of attack that the resulting sandbank will tend to divert the current.

In the improvement of the Min River for navigation this type of dike with slight modifications has been used with considerable success and at small cost. On this work the bamboo stalks are planted from 3 to 4 ft. deep and 6 in. apart in rows 12 in. apart, from ten to fifteen rows of the larger bamboo forming a dike, as shown in the accompanying illustration.

In order to prevent the waving of the bamboo under the action of the current which often causes the stalks to break off just above the mudline, pieces of ½-in. split bamboo about 20 ft. long are woven between the stalks in each row, two or three lines of split bamboo being carried continuously throughout the length of a dike. The bamboo is cut off at about average high-water level to avoid the collection of floating material.

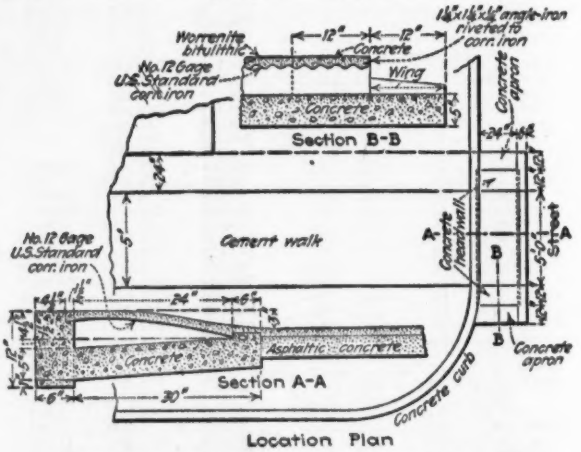
Bamboo permeable dikes have been used for several longitudinal training walls on the concave side of the channel to build up a new shore or bank for the improved channel.

This adaptation of native methods to important modern river improvement has been developed by J. R. West, engineer in chief of the Min River Conservancy, at Foochow, China. Its cost in that district, where bamboo is plentiful, is about $1.50 local currency (75c. U. S. currency) per lineal foot. The life of bamboo used in this way in the Min River is about three years, but if the dike is properly located sufficient accretion takes place to justify the expense.

Corrugated Iron and Concrete Used for Crosswalks

BY W. S. FARLEY
City Engineer, Paso Robles, Cal.

SATISFACTORY replacement of wooden crosswalks and drainage structures has been made in Paso Robles, Cal., through the use of corrugated iron embedded in and covered with concrete. In our paving program during the past year, we used Armco part-circle culverts. Properly installed, these are a solution



PLAN AND DETAILS OF DRAIN INSTALLATION

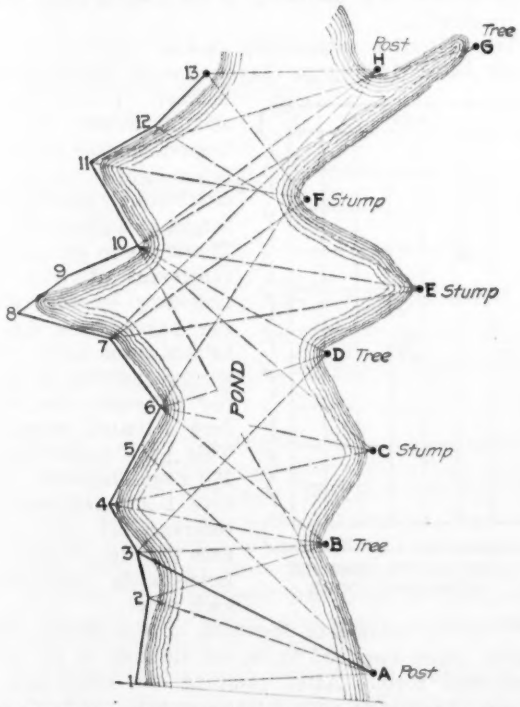
of many problems of railway and street drainage. Where sufficient headroom cannot be obtained to install a full circle, a heavy-gage arch of corrugated iron, installed between iron angles, in a well-built concrete base, and with a few inches of closely-packed covering, will satisfactorily and permanently fill the place of a far more expensive structure. This method of construction gives ample width for all purposes, with adequate waterway, and provides a smooth walk that is pleasing and artistic.

Survey Checked by Taking Side-Shot Angular Measurements

By George C. Love
Chief Engineer, Newport News Light and Power Co.

THE sketch shown herewith indicates a fair check of the accuracy of a survey traverse along the shore line of a pond. The traverse is run by azimuths along the shore and checked by intersecting lines noted to prominent objects such as trees or stumps on the opposite shore. Traverse points are indicated by the consecutive numbers 1 to 12 and the check points by consecutive letters *A* to *H*. Azimuths from three or more traverse points are necessary to check the location of any of the points on the opposite shore.

In the case illustrated the traverse along points 1 to 13 is plotted as usual. Then the azimuths turned from



LAYOUT OF TRAVERSE AND ITS ANGULAR CHECK

points 1, 3, 5 and 10 should intersect at *A*. Those from 2, 3, 4 and 6 should meet at *B*. Those from 4, 6 and 10 should intersect at *C;* those from 3, 6 and 10 at *D*. Those from 7, 10 and 12 at *E;* those from 7, 11 and 13 at *F;* those from 10 and 11 at *G;* and those from 6, 7, 10 and 13 at *H*.

A form of notes for traverse and check method is suggested below. It is better to record from the bottom of the page upward.

Set-Up No.	Survey Station To	Object or Station	Distance	Azimuth	Needle Reading
.....	.....	.....	.....	.....	.....

Azimuths should be carried on the plate of the transit with the line of zeros always oriented into the meridian. If the plate is suitably numbered it is as convenient to carry the bearings along as courses in the various quadrants to correspond with the needle readings.

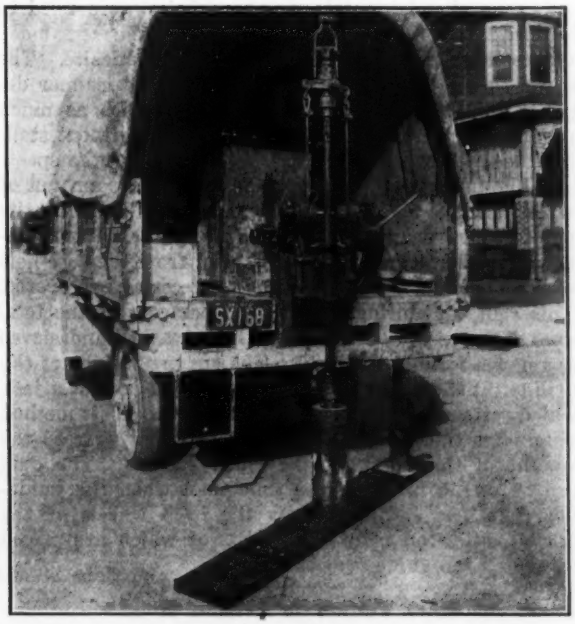
The method outlined above has these advantages:

1. Any considerable error will be apparent when the lines fail to intersect at a common point.
2. If there is an error, it is a simple matter to determine about where it is so that the whole traverse need not be run again.
3. It is a sufficient check for many purposes and will often give assurance that a traverse is substantially correct without the labor of closing a circuit on the ground or checking over angles and measurements.
4. It is adaptable to many circumstances where there is unobstructed view of prominent objects to check on.
5. In cases like the one illustrated it serves to locate the outline of the opposite shore.
6. It need not delay the progress of the party materially for the transitman can generally find time for the "side shots" during delays caused by clearing brush or the like.

Drill Averages Eight Cores per Day on New Jersey Pavements

By J. C. Bragg
Senior Testing Engineer,
New Jersey State Highway Commission

IN MAY 1921 the New Jersey State Highway Department purchased a Calyx core drill such as is described in *Engineering News-Record* of January 12, 1922, p. 53. This outfit has since been used quite successfully, not only for the purpose of investigating completed projects, but in a number of instances to determine location



IMPROVED SCHEME OF HOLDING GUIDE-BOARD

of reinforcement or depth of pavement on projects under construction.

In a general way there is fair agreement between the figures presented by Messrs. Dunn and Coolidge and those compiled by this department. However, we find a marked difference in the rated capacity of the drill compared with actual data kept by the New Jersey drill corps. Altogether 724 borings were made in concrete ranging in age from 7 days to 3 years. The depth of cores cut was from 4 to 12 in. and while most of the

borings were made in comparatively rich concrete, quite a number were cut from base concrete of 1:2½:5 proportions. The coarse aggregate used in these pavements is fairly well divided between trap-rock and gravel, with a few dolomitic limestones. The average depth of all borings is 7.5 in. and an average day's work (not including moving from one job to another) is 8 cores with a maximum of 10 cores per day.

Messrs. Dunn and Coolidge state that this outfit averages 16 cores per day. They further state that from 15 to 25 min. are required for cutting each core. From these figures we may assume an average of 20 min. per core. Obviously, the drill cannot be moved ½ mile and the set-up made in less time than that time. At this rate the total time required for drilling 16 cores becomes 10 hr. 40 min., and no time has been allowed for running to and from storage, filling with gas and oil, replenishing the water tank, etc. Our drill operator reports 35 min. as a minimum for the time necessary to drill through 8 in. of good quality trap-rock concrete, and estimates as an average, 45 min. actual drilling time per core.

The New Jersey drill corps consisted of 3 men, a junior engineer in charge, assisted by a truck driver and his helper. All data relative to location of cores, condition of slab, etc., was attended to by the engineer. When time was available he also assisted in the filling of core holes. In most cases the core holes were filled with concrete to which an accelerator had been added, and which was mixed while the core was being drilled. In some cases, where it was desired to examine the subgrade at a later date, the core holes were filled to within 2 in. of the surface with stone, the remainder of the hole being filled with top-course Amiesite. The actual cutting of the core was done in the manner described by Messrs. Dunn and Coolidge with as much pressure applied to the drill as is possible without stalling the drill motor or appreciably decreasing the speed.

While no exact figures were kept as to the amount of water used we find that the estimate of 3 lb. of Calyxite per core practically checks our own figures. When taking a sample of the subbase material from the core hole such shot as had not been ground to pieces was recovered. This shot, amounting to about 25 per cent of the total used for cutting each core, was later washed and sieved to remove foreign material. The sprung weight of the drill outfit shown on p. 864 is raised by means of a jack which rests on one end of the guide board. This method eliminates the necessity of using a timber to keep the weight of the outfit off the truck springs. The drill can be set up in much less time than when the guide-board is held in position by the back wheels of the truck resting on planks, the ends of which are placed on top of the guide-board.

Rock Tunnel on Arizona Road

A Federal-aid road being constructed by the State of Arizona will shorten the distance from Superior to Miami from approximately 100 miles to 20 miles. Much difficult work has been encountered on the job, including a tunnel 277 ft. long, being constructed through solid rock.

FROM JOB AND OFFICE

Hints That Cut Costs and Time

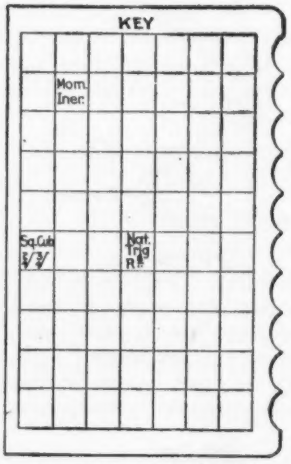
New Method of Thumb Indexing Books

By A. C. Hewitt

Office of Chief Engineer, Way and Works, Government Railways, Perth, West Australia

TIME-SAVING, where possible, is the order of the day. The time saved by using thumb reference indexes compared with alphabetical indexes is considerable, but one of the disadvantages of thumb indexes lies in the fact that they are not comprehensive enough. The latest edition of Trautwine, for instance, with over 1,500 pages, has sixteen thumb references, whereas there are about seventy sections in the book to which rapid reference is desirable on the part of those using it frequently.

The writer has successfully used as many as 70 references on a 1,200-page Trautwine in the following manner. It was decided at the outset that the largest number of thumb holes which could be satisfactorily placed in the length of a page was ten. Therefore to get seventy references it became necessary to work down the pages from top to bottom seven times. The average number of pages per reference was therefore about seventeen. This gave approximately 170 pages between reference 1 and reference 11, reference 11 and reference 21, etc., which were immediately underneath each other.



KEY-SHEET USED IN INDEXING BOOKS

To allow convenient insertion of the thumb about eighty pages required to be cut through in the usual segmental form. After planning the references required (Trautwine divides into convenient sections very readily), it was not difficult to cut the thumb holes with a sharp gouge, never cutting through more than 80 pages.

The usual method in thumb indexing is to print an abbreviated title of the section in the thumb hole. With as many as seventy references this became impossible, and a key-sheet was prepared and placed on the blank page immediately preceding the title page. A copy of this key-sheet with but one or two references filled in is shown herewith.

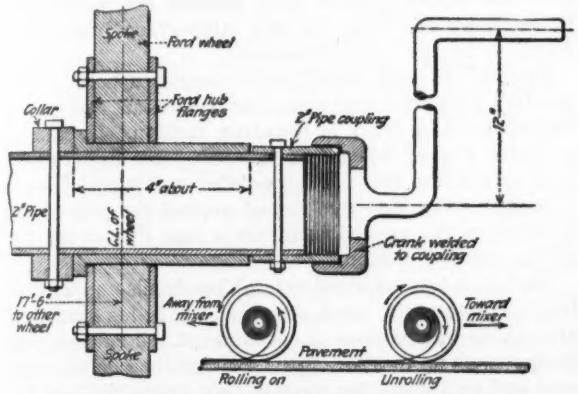
In using the index the book is opened at the key-sheet, and the eye is run over the titles, which are carefully chosen to catch the eye quickly, while being as short as is consistent for the purpose. Suppose we are seeking moments of inertia. Place the thumb in position at the edge of the book opposite the reference "Mom. Iner." While doing this the fact that the reference is in the second column, or the second down in the thumb-hole rows, is noticed and we rapidly drop the thumb onto the required thumb hole. The reference is made much more speedily than it is described.

FROM JOB AND OFFICE

For Contractor and Average Engineer

Homemade Device for Placing Burlap on Fresh Concrete

THE PRACTICE of covering fresh concrete pavement with burlap to prevent too-rapid drying out and consequent surface checking before the concrete can set sufficiently to permit of covering it with dirt was commenced on state highway work in California about a year ago. California highway commission specifications now require that green concrete shall be

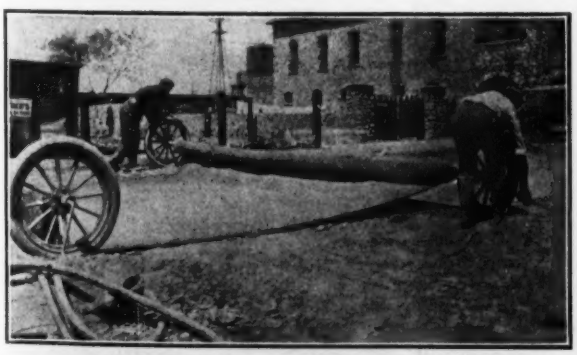


CONSTRUCTION OF WHEEL HUB AND HANDLE

The bushing is turned to fit the 2-in. pipe and is welded to the hub flange. Small scale sketch indicates most convenient method of rolling and unrolling burlap.

so protected. Since this requirement has been adopted there has been no further difficulty with surface checking, such as had previously become quite common particularly where the pavement was exposed to hot sun or dry air. As a means of facilitating application of the burlap immediately after the concrete is poured a reel spanning the pavement has been devised with which two men can speedily and easily unroll burlap onto the concrete or roll it up again.

The reel consists of two Ford wheels supporting a shaft of 2-in. pipe. For handling burlap in strips 16 ft. wide an 18-ft. length of pipe is used. The pipe rests in closely fitting bushings which are welded to the hub flanges, as shown in the accompanying sketch. The ends of the pipe project through these bushings and removable handles are used to turn the shaft in



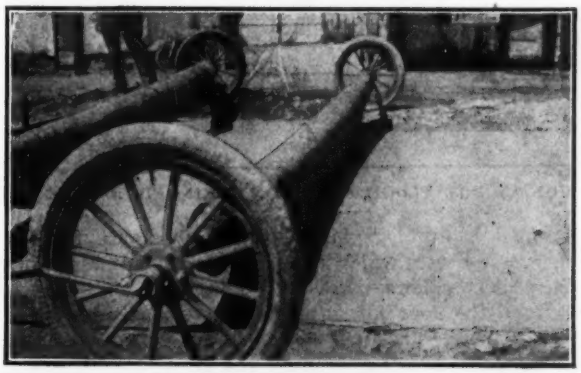
PLACING BURLAP ON FRESHLY-POURED CONCRETE

the bushings when rotation of the reel is desired independently of the wheels.

One advantage of this construction is that it allows burlap to be wound or unwound without turning the wheels or when the wheels are turning, as may be desired. Also, the reel can be rolled forward or backward as a whole without allowing the axle to turn.

Two reels are ordinarily used and about eight 50-ft. lengths of burlap. This is enough to cover the ordinary half-day's run. Two men handle a reel and another sprinkles the burlap as it is unrolled. It is essential that sprinkling be done at the same time as the burlap is unrolled, using a spray nozzle to prevent pitting the concrete. If kept wet the burlap will not stick to the concrete. Under ordinary conditions the burlap is kept on for three to four hours. When the burlap is removed the pavement is immediately covered with dirt and prepared for the regular curing process. As rolled up the burlap is usually more or less wet and in this condition a 50-ft. roll is estimated to weigh from 200 to 250 lb.

The burlap is wound carefully to keep it straight on the reel and free of wrinkles so that it will unroll evenly. In unrolling the handles are used to regulate



CLOSE-UP OF THE REELS

the desired rate of turning the shaft so as to avoid the necessity for pulling or stretching the burlap after it is laid, which might cause irregularity in the concrete surface. Experience of the California highway commission indicates that the burlap should be discorded and replaced after being used on about 3 miles of pavement.

Earlier methods of placing burlap were by hand, usually taking 6-ft. strips of a length slightly greater than the pavement width. The use of 20-ft. lengths was tried but was abandoned as too expensive when it was found that about eight men were required to properly handle such large pieces.

Iron Ball Bulldozes Foundation Rock

IN SHOOTING drill holes for excavation work in New York City the schist encountered often splits into too large sizes to handle easily. Bulldozing shots are rather dangerous. To break this rock to convenient sizes the Clarence L. Smith Co., Inc., foundation contractors, uses a 1-ton iron ball, fitted with an eye-bar. This ball is handled by the derricks, which drop the ball on the rock, crushing it into sizes which are easy to handle.

Portable Trestle Horses for Concrete Forms

IN THE construction of the new concrete bridge across the Connecticut River at Springfield, Mass., standard horses are used to carry the forms for the floor construction. The accompanying view shows some of these in place. They are of trapezoidal sections cut with the long and short legs to fit the rise of the arch and

HORSES FOR FLOOR FORMS ON SPRINGFIELD BRIDGE

of equal length legs but of varying heights for the transverse horses which span between the adjacent arch rings. These horses are set up in place on the arch ribs and the floor forms placed upon them. After the floor is poured they are moved over to the next arch.

The work is being done by the H. P. Converse Co. and the engineers are Fay, Spofford & Thorndike of Boston.

Whitewashing Structures Along State Highways

By P. E. Burroughs
District Engineer, Maryland State Roads Commission

DURING the winter of 1921 the writer made some experiments and observations to determine a good inexpensive wash for whitewashing public service poles, culverts, headwalls, and other structures along highways. The formula finally used was: ½ bag hydrated lime, 6 lb. common table salt, 1 pint molasses, 3 oz. ground alum, and 10 gal. hot water about 1,750 deg. F.

Molasses renders the lime more soluble and causes it to penetrate the surface to be painted. Alum gives an added adhesive power to the wash. Hydrated lime or a factory slaked material is preferable to a hand or field-slaked lime. These ingredients thoroughly mixed give a yellowish paint that whitens upon drying. Best results were obtained on poles that had stood two years. New poles bleed and will discolor any wash after the first year's application. Again the kind of wood has a great influence upon the results obtained. Cypress and chestnut give the best results with a slight preference given the former.

FROM JOB AND OFFICE

Hints That Cut Costs and Time

The best results were obtained with the use of the following equipment and organization. 1 G.M.C. ambulance truck, 1 50-gal. heating kettle or tar pot, 2 bbl. for mixing, 6 3-gal. pails, straps and brushes, one foreman, and four painters.

Enough material was carried out in the morning for the day's work. The heating kettle, trailing the truck, was used for heating the water. The kettle was filled every time water was easily obtainable. Two mixing barrels were used. In this way the foreman and chauffeur had ample time to keep enough hot water and mixed wash on hand. A very high-grade brush was found to be the most economical.

One pail of wash would paint about ten poles. The painters were separated about ten poles apart and transferred ahead by truck in leap-frog fashion. In case of a double line of poles, two painters were assigned to each side of the road. Each painter was supplied with a leather strap that was lashed around the pole about 4½ ft. from the ground to insure a neat line at the top of the painted section.

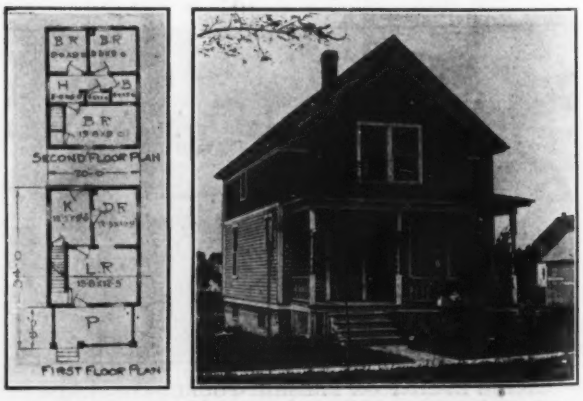
Each man was required to wash headwalls and all protecting fence posts, trees, etc., that fell in his span, and everything was finished as encountered. All culverts and bridge walls up to 25-ft. spans were washed on the road side and two ends, the outside face being omitted except where the headwall fell on the inside of a sharp curve.

That this work can be done at a very low cost can be seen by the fact that we covered 220 miles at an average of $2.71 per mile, including all materials, labor and incidental expenses, except the chauffeur's salary. This average per mile cost was distributed as follows: Labor, $1.48; straps and brushes, $0.06; lime, $0.48; salt, $0.08; molasses, $0.06; alum, $0.12; truck expenses, $0.43.

Plan and Photograph of House Shown on Same Print

By Norman G. Ray
Civil Engineer, Massona, N. Y.

IN THE endeavor to make more effective a house-selling campaign, a system was devised whereby both the plans and a print of the house were included on the



PRINT CONTAINS HOUSE PLANS WITH PHOTOGRAPH

FROM JOB AND OFFICE

For Contractor and Average Engineer

same photograph. By such means the prospective buyer was able to get a better idea of what the house was like and therefore need waste no time in visiting houses that did not suit his ideas.

A wooden frame the size of the space required for the title and plan was inserted in a camera directly in front of the ground glass and the exposure of the house was made. The title and plan were drawn on a piece of tracing cloth the size of the plate or film. An opaque mask slightly larger than the exposed part of the film was placed in a printing frame and the tracing placed over it with the printing exposed. The film was then placed over both mask and tracing. Care had to be taken in transferring the film to keep the exposed part covered by the mask. The back of the printing frame was then clamped on and the film exposed.

For any person using this method the first time it would be best to take several pictures of the same object so that should the first exposure of the tracing come out badly, a second one could be made.

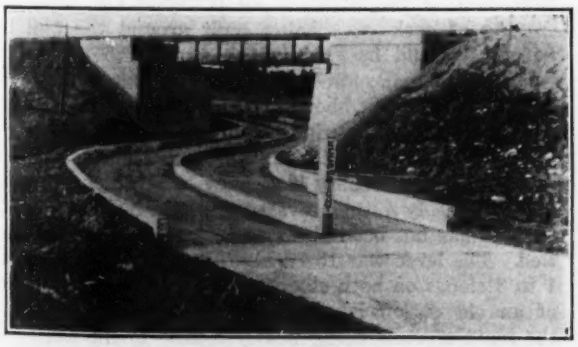
When the film has been exposed to the tracing the usual method of developing it is then followed. When printing it is best to use an opaque mask to give a white border and a division between the picture and the plan. If the negative has the same density all over, one exposure will give a print, otherwise the whole is exposed and then the light cut off from the center portion and the balance exposed for the proper length of time.

Highway Underpass Has Central Curb as Guide to Traffic

BY B. H. FABER
Engineer, Colorado County, Texas

TO PREVENT motor-vehicle accidents at an underpass below the Southern Pacific R.R. tracks at Weimar, Texas, where the view of the driver is obstructed at a reverse curve by the concrete abutments of the bridge structure, a special type of construction involving a central curb as a guide to traffic has been employed, as shown in the accompanying photograph. The length of the underpass equipped with curbing is 200 ft. and in addition there is a 200-ft. length of concrete-paved approach.

The width of the underpass paving is 20 ft., divided by the central curb into two 10-ft. lanes. The curbs are 8 in. high and at each end there is an 8-in. square reinforced-concrete post carrying the warning, "Keep to the Right." The pavement proper is 7 in. thick, reinforced with ¼-in. round bars on 12-in. centers both ways.

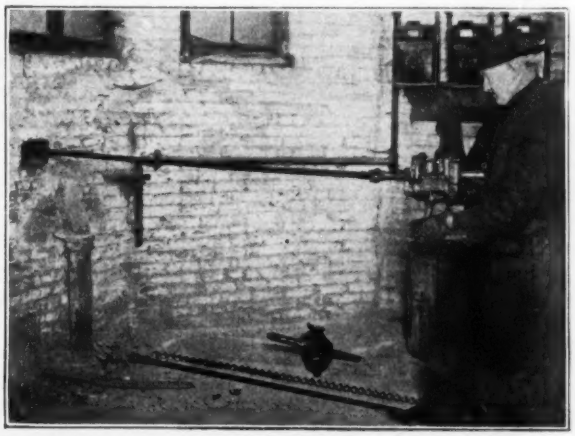


CENTRAL CURB PREVENTS COLLISIONS OF VEHICLES

The highway portion of the underpass cost about $5,000 to construct. At the point of crossing under the railroad tracks the alignment called for 30-deg. curves.

Air Drill Eliminates Trenching For House-Service Pipes

TESTS MADE by boring or drilling from cellar to curb using air drills disclose a considerable saving over the trenching method in installing house-service pipes. Fifty-three services aggregating about 1,000 ft. of pipe were recently installed in New York City. In installing a service the cellar wall was first cut through with a chipping hammer. Then an air coal drill completed the boring, coal augers and three lengths of extension bars being used. The illustration shows the first drilling operation which carried the hole 10 ft.



INSTALLING HOUSE SERVICES WITH COAL DRILLS

On the floor are the long auger and extension bar for the final drilling operation.

According to the tests (which were made in installing electric services) a saving of over $8 a service was shown in comparison with trenching and back-filling and removing and replacing sidewalk flags. The tests were made by the Brooklyn-Edison Co., Brooklyn, N. Y., using Boyer hammers and Little Giant reversible coal drills.

Track Scales Showing Wheel Loads

Track scales for locomotives, to indicate the weight carried by each wheel, are used by several English railways, according to the *Railway Gazette*, London, in commenting upon the large track scale for this purpose described in *Engineering News-Record* of Nov. 17, 1921, p. 808. In the English design, each rail of the scale table is divided into several independent sections, each of which is mounted upon an independent scale. Thus with a locomotive on the scale, separate dials show the weights upon the several wheels. This arrangement is satisfactory for individual railways, but for locomotive works building engines of extreme variety in size and wheel arrangement it probably would be difficult to divide the scale satisfactorily.

Flood Water Conditions on the Lower Mississippi

Crevasses at Three Points Have Reduced Predicted Crests—None to Be Closed—Tying Ends—Loose Earth for Topping

By W. W. De Berard
Western Editor, *Engineering News-Record*

THERE were three crevasses in the Mississippi River levee system below the Louisiana-Arkansas line during the high water of April; one opposite Natchez in Louisiana at Weecama Plantation near Ferriday, a second at Poydras in the east levee 12 miles below New Orleans and a third at Myrtle Grove 35 miles below New Orleans in the west levee. The dates are April 25, 27 and 23 respectively for the three breaks. They occurred at or near the highest stage of the river ever recorded at New Orleans, 22.7 on April 28. The crevasses have given sufficient outlet to check the rise to the predicted 23.5-ft. stage, although with the falling river upstream it is doubtful whether that stage would have materialized even though the levees had not broken. All three crevasses have been sudden collapses of such magnitude as to make any immediate measures futile and nothing will be done at any one of them to close the openings until the high water recedes.

Early ineffectual attempts were made to tie the ends of the Weecama break. Nothing has or will be done with the Myrtle Grove crevasse, but the lower end of the broken levee at Poydras by May 6 had been protected by a single row of wood sheetpiles driven 400 ft. away from the slowly crumbling end. The upper end in slack water was not washing; however, it was the intention to tie it when the writer inspected the crevasse on May 6 in company with Major J. T. Butler, Corps of Engineers, temporarily loaned from Wilson Dam to Major R. T. Coiner, Corps of Engineers, district engineer in charge of the Fourth District of the Mississippi River Commission.

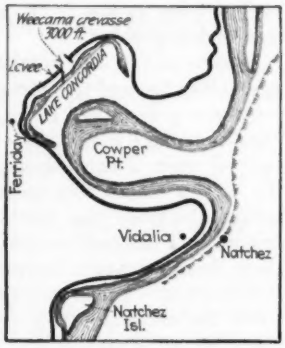
As in the Third District of the Mississippi River Commission, noted in the *Engineering News-Record*, May 18, the same energy has been displayed in the expansion of the skeleton military organization of the Fourth District. The same co-operation has been effected with the local levee boards, state and municipal officials and relief agencies.

Low places in the levee for 60 miles have been topped with sacks or the crowns built up with loose earth behind timber bulkheads. Boils and back-slope protection has been similarly handled. More use has probably been made of highways because in general well-graveled trunk lines follow the toe of the levees. The loose earth has been handled by wheelbarrows, by teams and by barges. Wherever possible the earth has been taken from abandoned levees. Moving teams up the back slope was not desirable but the necessity of speed has at times made it imperative. Major Coiner had recently obtained levels of all the levees in his district so that the location of low places was known and plenty of time elapses before rises in the upper river show below. A Cairo crest appears at New Orleans in about four weeks. In general the lower levees are not so high as those farther upstream. The natural river banks have been built up to comparatively higher elevation near the outlet. This fact is fortunate for in some places the material will not support high embankments.

POYDRAS CREVASSE, 800 FT. LONG, AT AN EARLY STAGE

Weecama Crevasse—The crevasse at Weecama Plantation is 4 miles above Ferriday and was preceeded by a sand boil in the highway 20 ft. from the levee toe. A ring of sacks was being built around the boil but before it could be raised high enough to reduce the velocity below the silt-carrying point undercutting was sufficient to permit about 40 ft. of levee to subside and blow out. This opening rapidly extended to several hundred feet in width as the available embankment material in this locality is a sandy loam which crumbles fast. By May 7 the crevasse had widened to 3,000 ft. Closure has not been attempted nor have the ends been tied. The levee was 15 ft. high, had an 8-ft. crown and 1 to 3 slopes on both sides. The site is along the bank of an old cut-off lake where there was little current, the main channel being nearly a mile to the east. No particular anxiety had been felt over this point because

of the distance from deep water and swift current. Little relief was to be expected at New Orleans from this crevasse because the escaped waters finally find their way back to the Mississippi through the Red River. It is estimated that the area flooded will total 1,000 square miles, although much of this acreage was already covered by back water from local sources.



WEECAMA CREVASSE ABOVE NATCHEZ

Poydras Break—The failure at Poydras Plantation occurred on the outer side of a large horseshoe turn and was caused by undercutting of the 200-ft. batture and the levee by the main river current. This is one of the few water-side breaks in a levee brought up to standard grade. The section is practically that of the Mississippi River Commission, with the exception of the banquette. The break occurred at 2 a.m., a few minutes after a guard had passed. It is estimated that from 300 to 400 ft. slid into the river. Before assistance could be obtained the river had cut away the tough "buckshot" embankment to the ground surface and the velocity due to the 14-ft. difference in head was cutting away the ends of the levee. A decision to delay closure until the high water receded was reached because of the excessive cost. Further it was considered that about as much damage had been done to the truck farms which are inundated as would occur if the break were left open. If the backwater is not stopped at the new industrial canal below New Orleans there is a protection levee below the city.

Tying Ends of Poydras Break—A contract for tying the ends of the Poydras crevasse was entered into with W. M. Wren, contractor. The procedure was to drive 30-ft. patented locked tongue-and-groove, triple-lap wood sheetpiles in the form of a bridge abutment, 30 ft. across the crown, 70 ft. in a wing down the slope on the river side and 100 ft. on the land side. The point chosen for the lower end was about 750 ft. back from the original break. Before the work was completed about 400 ft. had been eaten away. Work started May 1 and was completed May 6. The upper end is in slack water and although it is not cutting it will be protected.

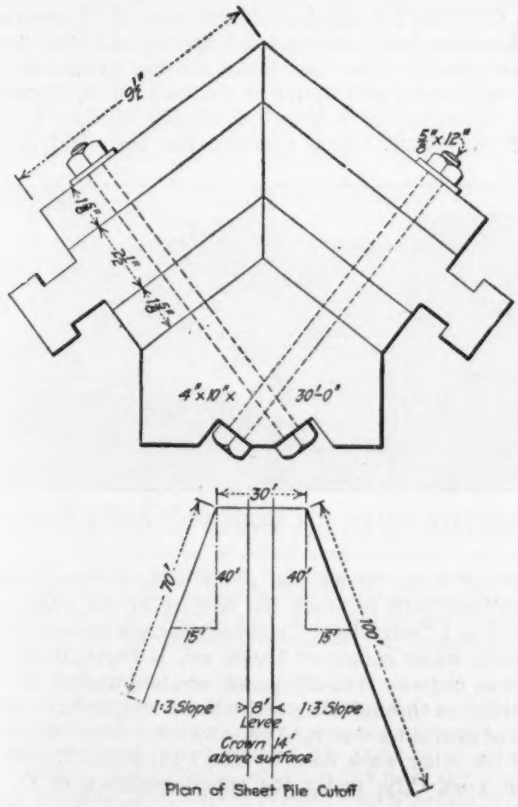
Two pile drivers on barges with 10,000-lb. steam hammers were pulled through the 500-ft. stretch of timber between the river and the levee by anchoring

DRIVERS WORKING ON PILE "TIE" AT POYDRAS

to a deadman in the levee. Willows as large as 6 in. in diameter were pressed down as the barges passed over them. One of the barges was old and the contractor sunk it on the river side just above the line of piles after rolling the driver it carried onto a pile platform along the levee. It required three days to set up and two days to drive the 200 ft. of piles.

Barges carrying material and supplies, loaned by the commission were anchored in the willows on the river side. A way through the willows was cut by running a small boat back and forth several times. The sheetpiles were "snaked" in end to end, being fastened together by a 3-ft. board and 20 d. spikes.

The sheetpiles are made of a central 2½ x 9-in. plank and two outside plank 1¼ in. thick. As they arrived on the job they were spiked every 18 in. with 60 d. spikes, clinched on the far side. Some of the piles were shattered in driving and had a tendency to buckle, so an additional row of spikes was driven, making the spacing 9 in. c. to c. Near the water line the 10,000-lb. hammer would force the piles down the first 8 ft. without driving. The last blows effected but 2 or 3 in. penetration. The lock in these piles is designed to swell 4 per cent and make a watertight joint. Special angle pieces were designed as in the sketch. The piles were tied together near the top by a 4 x 6-in. wale on each side, held in place by ¾-in. bolts every 3 ft. The contractor's crew was quartered in government tents set up on one of the supply barges.



PILES DRIVEN TO "TIE" ENDS OF POYDRAS CREVASSE

Myrtle Grove Crevasse—The break at Myrtle Grove

Plantation occurred in the middle of the night in an 8-ft. levee and was due to a sand-boil blow-out as at Weecama. The flood water now flows across a strip of comparatively high land averaging a mile in width and then across flat sea marshes into bayous and lakes connecting with Barataria Bay. No attempt will be made to do anything with this break until the flood subsides.

Earth Topping—In the Fourth District the practice of raising the crown with loose earth rather than with sacks is based on the theory that sacks are hard to make watertight, especially at the tops and bottoms. Further sacks are hard to get and expensive to fill. The loose earth is easy to handle in wheelbarrows from the fields or from barges, by teams with slip scrapers or by truck over the highways if necessary to haul from a distance.

In constructing the timber bulkhead a 2 x 4-in. stake is driven about 1 ft. from the water edge of the crown and one, two or three 1-in. boards 12 in. wide are nailed to the land side of the stakes. The bottom board is set into the ground an inch or two. If straight-edged boards cannot be obtained and cracks show, strips of burlap or sacks are split down the sides, laid on the ground and tacked against the boards before the earth is dumped against the bulkhead. The top width of the added earth is made sufficient to meet the continuation of the original back-slope on the levee, if the height is 2 ft. or more

Locomotive Operates Vicksburg Water-Works During Flood

ALTHOUGH the high-water level in the Mississippi at Vicksburg during the recent floods was sometimes at least 30 in. above the floor of the water-works pumping station—up to the grates of the boilers and near the tops of the filter walls—operation of the pumps and filters was continued without interruption. When notice of the highest-of-record stages was received, J. A. Steele, Jr., general manager and superintendent of the water-works, had brick and concrete bulkheads placed in all of the doorways and sack bulkheads laid along the water side of the settling basins and filters. In consequence the operators worked in the dry whereas in the 1916 flood they had to wade around the station in 2 ft. of water.

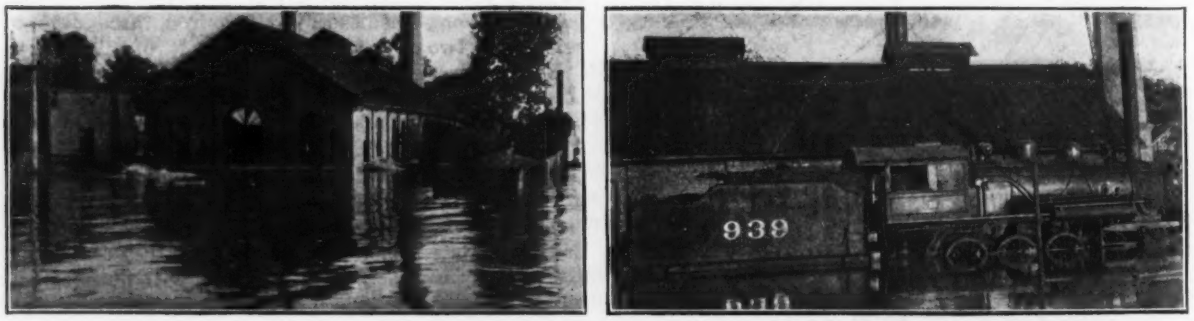
After the 1916 experience Mr. Steele waterproofed the brick walls of the pumping station by plastering with concrete on the outside. The concrete floors were also waterproofed and all cracks repaired to eliminate seepage. The walls of the filtered-water and settling basins were raised 2 ft. and the walls of the former were waterproofed.

In case one of the bulkheads had given way, or seepage gotten beyond the control of the various sump pumps temporarily installed at various points, the fires in the regular boilers would have been extinguished. To guard against such a contingency the Illinois Central loaned the city a locomotive with an 800-hp. boiler. A coal siding alongside the station was raised 2 ft. and the engine run in before the flood reached the crest, as there is a low place between the station and the main switch yard. The water had receded but a few inches when the accompanying views were taken by a representative of *Engineering News-Record*. At that time the water came up on the engine about 30 in. The firebox was then about 2 ft. out of water. On account of annulled train service due to high water (for 30 miles north of Vicksburg backwater covered the tracks) plenty of engines were available. After making a steam pipe connection from the locomotive to the pumps a test of 48 hours was run to make certain that everything was in working condition. Up to May 5, when the water was slowly receding, no regular use of the locomotive had been required. To furnish it and the station with fuel, several cars of coal were brought in behind the engine.

Two sets of new boilers have been ordered to replace the old ones, which had stokers set too low and also which burned pea coal formerly costing 35c. per ton and now $6.50. The new boilers will be set for flood stages of 40 ft. which is more than 2 ft. above the present crest elevation of the flood.

Water Supply for Bermuda Golf Course

A CONCRETE paved catchment area of 3½ acres and storage basins with a total capacity of 1,250,000 gal. have recently been completed for the greens of the new mid-ocean golf course at Tucker's Town, Bermuda. The catchment area is on the sloping hillsides adjoining the course. Here concrete has been laid to the depth of 6 in. Baffle and guide walls of coral blocks have been built to break the velocity of the water and lead it to a "catch basin" and five concrete storage tanks. A daily water supply of 10,000 gal. is required for the 18-hole course. The 52 in. of annual rainfall is well distributed through the year, which simplified the problem of providing water. The catchment area was paved and the other work done by The Foundation Company, New York City, under the superintendence of C. W. McInnes.



FLOOD BULKHEADED OUT OF VICKSBURG PUMP STATION—LOCOMOTIVE READY FOR EMERGENCY STEAM SUPPLY

Practical Regulation of Highway Transport

By E. J. Mehren,
Editor, *Engineering News-Record*

An Address Before the Highway Transport Session of the Chamber of Commerce of the U. S. A., Washington, D. C., May 16, 1922

As recently as two years ago discussion of regulation as applied to highway traffic would have been confined largely to such topics as the restriction of weight, speed and size of vehicles. Those topics are still important, but there has entered a new phase—the regulation of vehicles operating for hire as common carriers. I propose, therefore, to divide the subject—highway transport regulation—into two major divisions, the regulation (1) of motor vehicles generally, and (2) of common carriers. I fully realize that the first division has had lengthy consideration. However, this seems an appropriate occasion for summing up, for taking stock, for finding where we stand on vehicle regulation and whither we should go.

Regulation in General—Let me call your attention to the wording of my subject. I was asked to discuss not vehicle regulation, but highway-transport regulation. The distinction is significant. It marks the change from the conception that the motor vehicle is an interloper on the highway or an instrument of pleasure, to the settled conviction that highway transport is an essential part of our social and economic life. It is not so long ago that highway officials and large sections of the public resented the new mode of locomotion. That time seems now far removed. Possibly the great war record of the highways marked the change in thought. Today we all accept the highway as a great economic instrument. Far from desiring to discourage its use, we encourage it, so that the benefits of economic transport may be extended as much as possible; so that the people, through savings in the cost of carriage, in time of transport or in comfort and convenience may get dividends on their highway investment.

These considerations may seem academic, but from them flow the basic principles which should control motor-vehicle regulation. If the highway be an economic agent of the public, the regulation should be such as to encourage its greatest use. Rules or laws which restrict its use unreasonably or make that use uneconomic run contrary to public interest. These economic truisms lead to the following principles:

1. Regulation should not be punitive.
2. It should prevent abuses by individuals who would invade the rights of others and make the use of the highway dangerous, uncomfortable or expensive.
3. It should be kept to a minimum consistent with maximum economic use of the highway.

It will be found that all sane regulation now on our statute books conforms to these principles. Excessive speed, for example, if general would drive away those whose regard for safety is normal. Excessive loads would break up the roads and thus prevent or curtail their use. Unusually great widths of vehicles interfere with passing and cut down the number of vehicles that can be put over the road in a given time.

It will be agreed that we have gone far in vehicle regulation—in some cases in a wrong direction—but the end is not yet. In the interest of the maximum economic use of the road there are needed in many states amendments to present law, first, for the sake of the states individually, and, second, in the interest of traffic that passes over state boundaries.

As to all such matters needing revision we have in the Uniform Vehicle Law an excellent guide. Only one feature of it failed to get the unanimous approval of the competent authorities who drafted it, namely, the question of maximum weight. This happens, too, to be the most important feature affecting interstate business. Nevertheless, it is the point where we must expect divergence of view, on account of difference in road experience and conditions. Considering the results of road-traffic counts it does not seem to be wise to insist too strongly on the 28,000-lb. limit, unless it be hedged with a provision allowing restrictions on certain routes.

Revisions Needed—If a vehicle law is to accomplish its purpose of promoting the maximum use of the highway consistent with safety, economy and convenience its mandates must be obeyed. We must be a unit for vigorous enforcement. Of special importance is the enforcement of weight restrictions of trucks. There was inclination, at first, to regard the Maryland method of dumping overloads on the highways wherever violating trucks were apprehended as too drastic. Its justice, however, was never challenged. Now there is a conviction that that is the only way in which weight restriction laws can be enforced. It may well have general adoption.

Tied up with weight restriction and its enforcement is the need for giving highway authorities power to limit loads to less than the legal limit, or to rule them off certain roads entirely, during the spring softening period. This is a generally accepted regulation that works to the benefit of the road-using public and of the public generally. The right to do this should be included in every motor-vehicle law.

There are other adjustments desirable in present laws. The horse-power and gross-load basis for assessing fees proposed by the uniform law should be generally adopted instead of the sixteen other ways found in present statutes. Where reduction in fees for pneumatic-tired vehicles is not allowed, such provision should be made.

These comments suggest that there is need right now for a new consideration by both interested and impartial parties of the present laws, to the end that there may be prepared for the meetings of the legislatures next winter sound conclusions as to present statutes and the desirable lines of revision.

Common-Carrier Reglation—Let us turn now to the regulation of common-carriers motor vehicles. The same principles obviously apply here as in the case of general regulation, namely:

1. That regulation should not be punitive.
2. That it prevent abuses that would invade the rights of others, and
3. That there be a minimum of regulation consistent with maximum economic use of the highway.

It is possible to make a strong theoretical case against regulation of motor-vehicle common carriers. There are sharp differences between the business of motor-vehicle transportation and that of steam and electric railways. Since the motor vehicle operates over a publicly-provided track, and the necessary private investment is small it is easy to introduce competition. Steam and electric railways, on the other hand, require a large capital investment; the introduction of competition is difficult. Again there is less to be gained, at least on the surface, by giving monopolistic privileges to motor-transport operators than to electric light, gas and telephone companies. Duplicate telephone systems are an inconvenience and an added expense to the public. So, too, are duplicate electric power and illuminating gas systems. In motor-transport duplicate investment is likely and a burden to the public, but the plant is mobile and if in operation the resulting ineconomies begin to pinch it is easy to move the equipment elsewhere. The duplicate plant investment is not an irremovable burden on the public.

But however strong the theoretical arguments against regulation there are practical considerations that outweigh them.

1. The public has long since determined that regulation of common carriers is necessary, and it is not likely, no matter how strong the theoretical argument, to make an exception in favor of highway transport.

2. Sufficient evidence has already been offered to show that where motor transport is heavy, the public is better served by regulated than by unregulated service.

3. Regulation offers the possibility of stabilizing the highway-transport business—saving it from the destructiveness of uninformed, fly-by-night competition.

Already there is strong sentiment both for and against common-carrier regulation. Where fly-by-night operators who do not know their costs have brought substantial operators into or near bankruptcy there has been a cry by operators for regulation and for the granting of monopolistic franchises. Where the public's interests have been made secondary to profit by those who sought to skim the cream, the public, in turn, has demanded supervision of service and of rates.

On the other hand, there have been those who have fared well in the motor-transport business so far, particularly over routes that would not justify common-carrier franchises. They object to the prospect of regulation. They are, in part, of the class who are willing to jump from place to place, picking up business while the going is good—in summer peaks for example—and leaving a local trustworthy operator to take the lean business.

Despite prejudice against it, however, it is likely that common-carrier highway transport regulation is here to stay. It has the advantages already cited, but it holds, also, the danger of checking development. It is possible that public regulatory commissions without adequate thought as to its applicability may slap onto motor-transport in its infancy much of the regulatory practice that has developed during twenty-five years of railway and other public-utility regulation. That this fear is not groundless is illustrated by the action of the Nebraska State Railway Commission. It took jurisdiction over highway transport and promulgated rules. After two years of trial it relinquished of its own initiative the control it had taken. It concluded that motor-transport in Nebraska had not advanced to the point where common-carrier regulation was necessary, that the cost data available were not sufficient for an intelligent determination of rates and that the commission lacked revenues for effective enforcement of its regulations. In other words, the commission concluded that it was dealing with an infant industry and that the nature of the child has not developed sufficiently to allow of intelligent direction. There is here a suggestion to other regulatory bodies that they accept the fact that this is an infant industry; that it is an industry different from other common-carriers; that it deserves study before regulation, to the end that the regulation may, broadly, be in the interest of the public.

Competitive Considerations—Two critical elements in motor-transport regulation are the rates to be charged by common-carriers and the fees to be paid by them. Some contend that highway transport rates should be set higher than cost plus a fair return in order to offset the advantage which the motor vehicle has because the public furnishes the track. This is proposed on the theory that it is the duty of regulatory bodies to offer some degree of protection to the steam and electric railways, which furnish their own track.

The argument is unsound. We are not unmindful of the cost to the railways of building and maintaining their own track, nor of the advantage to the motor vehicle of having its track furnished by the public. But we recall, also, that everyone has free use of the highway. A common-carrier motor truck transporting my goods for pay does nothing, in essence, but what I as an individual have a free right to do. I choose merely to employ an agent. To penalize him is to penalize me over and above a fair cost for service because I choose to take advantage of the economies or conveniences of an alternative type of transportation.

If we consider transport on inland waterways we find an analagous case. River and canal navigation require the dredging and maintenance of channels, which are done at government expense. We have at times charged a toll to help pay for the improvement, but we have not assessed a penalty to bring the rates on water-borne carriage up to those of the railways. On the contrary, we have gloried in the fact that water rates were lower than rail rates; in fact we have actually used water rates as a club to secure lower railway rates, and we urge that each type of transportation—rail and water—find the commodities it is best suited to transport, believing that thereby the nation will be most economically served.

Indeed, if the penalty theory is to be adopted what shall we do in the day when air transport becomes a formidable rival of land and water carriage. Shall we hobble it by penalty rates in the interest of the earlier forms of transportation?

Obviously, sound economics demands that we allow each type of transport to develop its utmost economies and to find its place in the transport system in accordance with the advantages it offers the public. If an earlier form suffers thereby, that cannot be helped. Every day in industry a new machine tool sends old ones to the scrap heap; new power units replace the old before the old are worn out. Waterway transport gave way in part to the steam railway; in turn the steam railway suffered a loss of business when the electric railway was developed. Now it is the turn of the steam and the electric railways to lose some business to the highways, but mind you that they will lose not all but only what the motor-vehicle can more economically or conveniently transport. They will retain what will be to the advantage of the public for them to retain. Also it is clearly foreshadowed that highway transport will prove to be a valuable adjunct and benefit to the railways. Already the motor truck is relieving them of the unprofitable short-haul business.

Naturally, the motor-vehicle engaged in common-carrier service must pay for the use of the road just as a privately owned and operated vehicle does. A tax graded by extent of use of the road is the preferable one, and where that does not exist a somewhat higher tax on the common-carrier is warranted because of the certainty of greater use of the road. Furthermore, since it has become a fixed principle of our system of taxation that individuals and corporations shall pay for the privilege of doing business on public streets, the common-carrier operator must expect to pay a franchise tax. At present this tax is in most states assessed in the form of a fixed fee, which is generally determined for passenger vehicles by the seating capacity. In levying these additional taxes the principle already laid down of not being punitive should apply. The benefits of motor-transport should be returned to the public directly in the rates rather than through taxes.

Conclusion—It is apparent then that the field of motor-transport regulation, whether of private or common-carrier vehicles, has many problems to which the minds of American business men need to be addressed. It is not enough that those with a business or professional connection with highway transport—the vehicle manufacturers and owners, highway engineers and highway officials—take interest in the subject. It touches too closely the welfare of American business and the American people to allow them to be indifferent towards it. The views and conclusions of the specialists need the endorsement and support of the public and particularly of the business community—which has the background to judge soundly of the solution of economic questions. It is well therefore that this Chamber of Commerce of the U. S. A. has given its attention to the matter. Its deliberations and conclusions should have an important influence. It may well advocate, in my judgment, the following broad principles of highway transport regulations:

1. That regulation be encouraging to highway transport and not punitive.
2. That it protect the rights of road users and prevent abuses.
3. That there be a minimum of regulation consistent with maximum economic use of the road.
4. That there be rigid enforcement of motor-vehicle laws.
5. That it is desirable, when the traffic warrants, that highway carriers engaged in regular transport service be designated and treated as common carriers, and be subjected to common carrier regulation, to the end

(a) That the public may be better served, and
(b) That the business of highway transport may be stabilized.

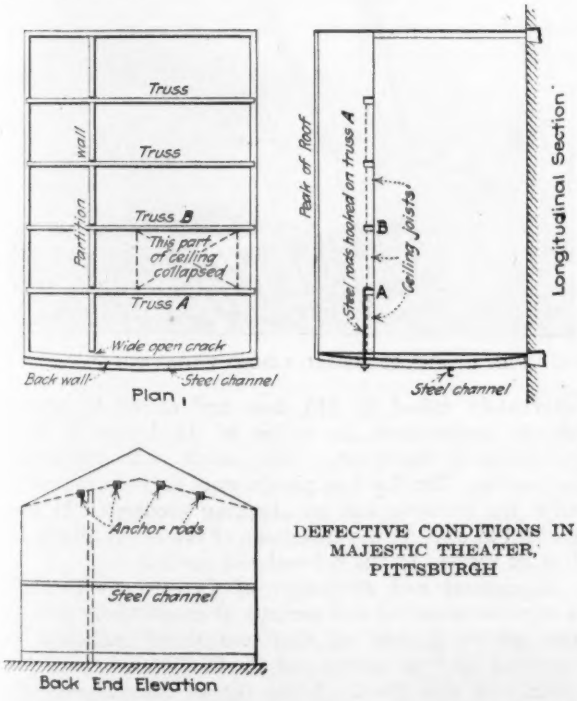
6. That common-carrier regulation, where adopted, should not be punitive but should permit highway transport to develop its own inherent economies and particularly that it be not artificially penalized and handicapped in favor of competitive forms of transportation.

Buckling Wall of Theater Causes Ceiling Collapse

Accident in Pittsburgh Movie House Made Out of Old Church—Bulge in Wall Imperfectly Held by Channel Backstay

By Edward Godfrey
Structural Engineer, Pittsburgh

On MAY 15 an accident occurred in the Majestic Theater, Pittsburgh, which missed being a calamity only by reason of the small attendance in the theater at the time and the unpopular character of the front seats. As it was, a number of people were injured and taken to the hospital. The accident itself was nothing more than a ceiling collapse, but it resulted directly from structural weakness and incipient failure of the building itself.



DEFECTIVE CONDITIONS IN MAJESTIC THEATER, PITTSBURGH

The theater occupies two-thirds of an old building which was originally a church. The church was simply a big box of an affair about 60 x 75 ft. in plan, with four wooden trusses spanning the 60-ft. direction. The old brick walls are about 50 ft. high; they are 13-in. brick walls in poor lime mortar. A partition or wall was erected, separating the theater portion from the remainder, which is occupied as a store. The ceiling of the auditorium is wooden lath, plastered, on 2 x 6-in. ceiling joints resting on 1 x 3-in. strips nailed on the side of the bottom chord of the roof truss, the joists being notched. The joists are also toenailed into the truss chord.

The end brick wall is bowed out nearly a foot. This condition is not recent. It evidently existed at least in a large measure, when in the course of converting the building into a moving-picture auditorium the ceiling was put in; had the bow developed subsequently, the ceiling would have dropped long ago.

A long steel channel anchored at the ends and with web horizontal was introduced on the outside of the wall. Its evident purpose is to prevent the wall from spilling out entirely. There is a long sweep in this channel as well as a vertical bow in the wall. Anchor rods connected the end wall and the first truss, but stopped here.

The sketch herewith illustrates the construction (measurements are only guessed at). The end wall has gradually bowed out further and further and pulled truss *A* with it by means of the anchor rods which were hooked onto it. This widened the space between trusses *A* and *B*, and the ceiling joists in panel 3 simply dropped out. The crashing down of this lumber smashed the theater seats to splinters; fortunately they were empty.

The rubble wall at the back of the end wall has very little mortar in the joints. The mortar in the brick wall can be picked out easily with a knife. The partition wall is cracked away from the end wall with a wide-open crack. Large cracks appear in the side walls near the end of the building, evident both inside and outside of the building; they are old cracks, for they are full of dirt.

The foregoing are all discoverable and easily discerned signs of impending failure. The building is said to have been examined two weeks before the disaster and pronounced safe

Life of Buried Steel Oil Tanks

AN INVESTIGATION recently carried out by the Factory Mutual Laboratories and reported in the quarterly of the National Fire Protective Association regarding the life of buried fuel oil tanks indicates that underground storage need not seriously impair the conditions of steel tanks. The investigation covered tanks which had been in service from 18 months to 26 years and were buried from 10 inches to 9 feet. Soils were sand, gravel, loam, clay or cinders or mixtures of these and in some cases ground water was present and in a few cases, salt tidewater. The tanks varied in capacity from 1,100 to 22,000 gal.

The investigation showed the following conditions:

(1) Cinders stimulate corrosion probably because of the electrolytic action between the steel and the carbon in the cinders. (2) The best soil coverings given in order of protective quality are: oily sand, sand, gravel, clay, loam and cinders. (3) Red lead followed by asphalt gives the best results as protective covering. (4) Tidewater and ground water do not stimulate corrosion to any great extent. (5) If a tank is buried below the zone of active oxygen it is usually below the zone of corrosion. (6) Steel tanks buried under favorable conditions should last more than thirty years. In damp ground they will last from 15 to 20 years.

To resist corrosion best steel tanks should be coated with red lead and asphalt and buried in clean sand 3 ft. or more below the surface, avoiding ground water and tidewater if possible.

Home Treatment of Lumber for Mill Roof with Creosote

Experiences Recounted in Roof Replacement Job—Green Lumber Successfully Treated by Hot-and-Cold Method

By William E. Rudolph
Engineer, Chile Exploration Company, Chuquicamata, Chile, South America

PRESERVATION of roof deck lumber of the A. P. W. Paper Co.'s Liberty Mill No. 2, Albany, N. Y., was carried out on the job by the "home-treatment" or open-tank method during 1920 when materials and labor were at peak prices. Experience with treating green lumber, cost of treatment and labor and difficulties encountered are here given.

Conditions in machine and beater rooms of paper mills are unavoidably most favorable to the rapid development of decay in wood roof decks and it becomes necessary either to choose a material that is not susceptible to this form of deterioration or to protect the wood, if one would have an economical structure. Wood lends itself so readily to simplicity in design and construction, that if proved means of making it resistant to decay can be employed, that is evidently the material to use. Such reasoning determined the decision to creosote the lumber for the roof deck over portion of Liberty Mill No. 2.

The experience of this company with the roof deck over its original tissue paper mill, Liberty Mill No. 1, lent emphasis to the need for preservative treatment. Erected in 1918 decay had seriously affected the lumber in 1920, and at this writing, after not quite four years, replacement has already become practically necessary. The deck had, as is customary, been carefully painted with the usual mill white, but that soon began to peel. Painting is almost valueless as a protection against decay under such conditions of humidity and when applied to green wood it accelerates rather than retards the decay. Careful study was given to both the preservative to be used and method of treatment to be employed. A refined coal-tar creosote oil and the open-tank process were chosen. The character and grade of creosote were important as it was obviously desirable to avoid excessive loss by volatilization during heating of the preservative in open tanks and also to have the treated lumber as clean as possible and of good appearance. As the purlins had to be framed and the roofers cut to size at the job treatment could not well be applied until after framing. This necessitated a home-treatment or the open-tank process.

Green Lumber Caused Trouble—The first difficulty was encountered upon arrival of the lumber. In the summer of 1920 material and labor could be secured only with difficulty and at high cost. It was the period when purchasers were fortunate to secure supplies irrespective of quality or suitability. Lumber especially was high in price and the better grades were not readily obtainable. As construction neared the point where the roof planks should be on hand—this was a time-limit job—arrival of the first car of lumber was an occasion for joy. But the disappointment was equally keen when upon inspection it developed that the lumber, merchantable pine, had been sawed green from the log, probably on the day of shipment, and was covered with sap-stain fungus. Of course it was not up to the grade of the owners' specifications nor of the contractor's order, but to reject it would delay completion of the building. The loss of a few days' production would have far overshadowed that which might ensue from using the lumber, even as it was.

Several means of remedying the situation were considered. One was to build a kiln around the lumber and steam it. A conference was arranged among the engineers of the contractor, the owner and the preservative manufacturer. The lumber could not be used green; it would not take creosote and was not worth the labor of placing it untreated. It was thought that to treat it at high enough temperatures to expel the moisture would cause severe checking. Finally, a few of the 3 x 6-in. roofers were placed over the paper machine hoods to dry, where they were subjected to 120 deg. F. for 72 hours. They lost 15 per cent in weight or approximately 45 per cent of the estimated moisture content without a sign of checking. This experiment gave hope to the suggestion that the moisture in the lumber might be boiled out by a prolonged hot treatment. A charge was placed in the treating tank and for 72 hours the temperature of the oil was

FIG. 1. SHEET METAL LINED TREATING TANK

alternately raised to 215 deg. and cooled to atmospheric temperature in cycles of 12 hours to each hot-and-cold treatment. The result was completely successful. The 3 x 6-in. planks were entirely saturated with the creosote and no checking occurred. It was decided to conduct the treatment of the entire 80,000 ft. b.m. of roofers by the hot-and-cold method.

Equipment and Procedure of Treatment—Through a misunderstanding and perhaps unintentionally erroneous advice it was at first considered sufficient to immerse the roof planks and the 26,250 ft. b.m. of 4 x 12-in. and 6 x 12-in. purlins for 10 min. in creosote heated to about 150 deg. F. With that advice in mind a wooden tank, 3 ft. wide, 3 ft. deep and 24 ft. long was built. The joints were well leaded and packed, but when used the tank leaked badly, proving the need of a tight metal lining. After fitting the tank with steam coils another trouble developed. The coils were connected with the steam supply pipe through the tank wall and had been carefully tested. A bad leak developed, creating considerable nuisance by adding hot water to the creosote and also eliciting much bad language directed quite generally at creosoting and new-fangled notions that were being added to the already severe burdens of good union workmen. However, this

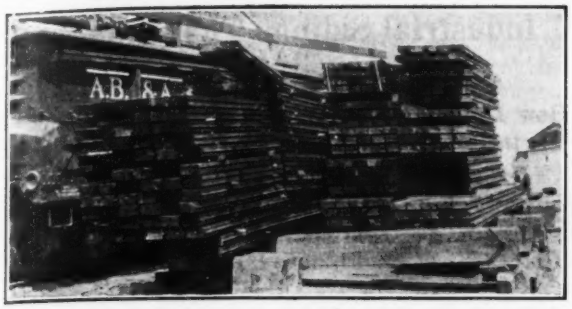


FIG. 2. ROOF PLANKS RACKED READY FOR TREATMENT

taught another valuable lesson, namely, that it is best to carry the coils over the tank so that in the event of leakage the coils can be removed readily without bailing or siphoning out the creosote. The experience cost $135, but the small expense items chargeable to experience were quite out of proportion to the eventual saving.

Upon starting treatment it was quickly discovered that 10 min. immersion was not sufficient to secure the desired impregnation. An engineer of the manufacturer from whom the refined creosote was purchased advised that the usual specifications for lumber of that grade called for an immersion of 30 min. first in the hot bath maintained at about 200 deg. F. followed immediately by immersion for a similar period in a cold bath, maintained at less than 100 deg. F. But this expedient also proved insufficient. It was then that the uselessness of attempting to treat green lumber without first expelling sufficient moisture to allow penetration of the oil was fully demonstrated. The experiments previously described were subsequently undertaken. The solution reached saved rejection of the green lumber. In similar instances it would be worth the extra cost to employ kiln-dried material where thoroughly air-seasoned stock cannot be secured. Mills should take the initiative in this respect, because if consumers cannot protect wood against decay it is far better to employ some other material for roof decks over machine rooms of paper mills.

Hot-and-Cooling Method Treatment Successful—Approximately two weeks remained before the laying of the roof deck would start and the 106,000 ft. b.m. of timber had to be creosoted without delaying construction; obviously the small tank would not do. A larger tank was then built. The dimensions were 3 ft. deep, 14 ft. wide and 22 ft. long. This tank was most carefully lined with sheet metal and tested before filling with oil. Steam coils were placed in the bottom and the connecting pipe carried over the top of the tank. The coils were covered with a grating of timber. (See Fig. 1.) A derrick was also obtained to handle the lumber in the required volume, the roofers being racked after framing as shown in Fig. 2. The capacity of this tank was nearly 10,000 ft. b.m. per charge.

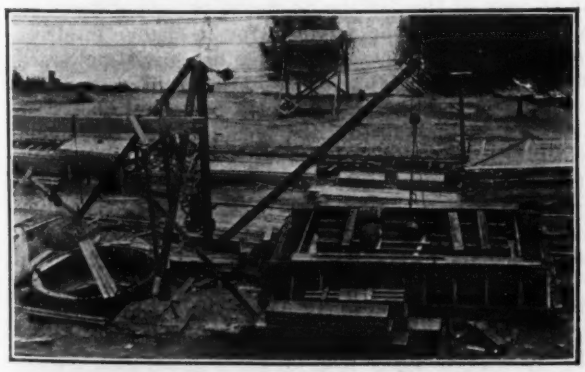


FIG. 3. LUMBER SUBMERGED BY TIMBERS AND FULL BARRELS

After treating a few charges of timber at the rate of one charge per day—half of the time for the hot bath during which the oil was heated to 215 deg. F., and the other half for the cold treatment when the creosote and charge were permitted to cool to atmospheric temperature—it was found that the planks absorbed 289 gal. for 2,750 ft. b.m. or around 100 gal. per 1,000 ft. b.m. As this amount was decidedly too much, the time of treatment was lessened to give an absorption of about 59 gal. per 1,000 ft. The revised schedule resulted in treating 5,000 ft. b.m. per day in two charges.

Schedule and Cost of Treatment—The schedule in this operation was as follows: 8 a.m. work started by removing charge left in the tank from the previous night; 10:30 a.m. the tank was reloaded with a new charge and steam turned on: 2:30 p.m. steam turned off: 5 p.m. unloading begun; 8 p.m. tank again charged, steam turned on: 12 midnight, steam turned off by night watchman.

The crew of workmen consisted of a "strawboss" carpenter in charge at $1.12½ per hour; two or three carpenters at $1 per hour (these were not needed during the treatment of purlins); seven laborers, two on the hoist, two on lift hooking on, two on lift taking off and one on guy line. The laborers received 70c. per hour and were employed 5½ hours per day on creosoting of which 3 hours was at overtime pay. The carpenters were used for racking lumber for 4 hours each day. Both carpenters and laborers received double rate pay on Sundays. This was exorbitant pay for this class of work which can readily be done by the most common of common labor, but these were the halcyon days for labor and this was a "closed-shop" job. The result was a cost of treatment totaling $67.65 per 1,000 ft. b.m.; divided $27.42 for creosote and $40.23 for labor and numerous incidentals. The separate items making up this cost are discussed further on. Incidentally 3 x 6-in. shortleaf yellow pine, merchantable grade, cost $90 per 1,000 ft. b.m. in place, and the purlins, No. 1 longleaf yellow pine, $115 per 1,000 ft. b.m. in place. Under normal conditions with properly seasoned lumber, the cost of treatment might have been $18 to $20 per 1,000 ft. b.m., divided $11 to $12 for creosote, $3.50 for labor and $3.50 for equipment.

The treatment obtained was much better than could have been secured by 30 min. hot-and-cold immersion, but in the absence of all mechanical wear on the lumber after being placed the briefer treatment and lesser absorption should readily have tripled the life of the roof deck. As it is, 20-years' life of this roof will probably be realized; 12 years' service will show a considerable annual saving, even at the $67.65 figure for treatment.

Some of the Details—After racking the lumber it was forcibly submerged as shown in Fig. 3. Had time been available mechanical means for bracing the charge fully submerged would have been developed to better

economy; but as previously stated this was a time-limit job. After treatment, the lumber was placed on a platform to drain with the object of drying it sufficiently to handle. That procedure also did not work out as planned for lack of time, and instead the lumber was held for a few minutes over the tank to drip. Although a hot creosote tank is no place for a dress suit and white kid gloves, during normal times certain troubles encountered on this job would not have occurred. Men were provided with rubber gloves and one or two even with rubber suits. They received $10 each for damage to clothing.

Placing the treated material was more costly than the untreated boards due especially to its greater weight. The extra charge for laying treated plank appearing on the record is $8.22 per 1,000 ft. b.m.; or $11.13 for the untreated planking and $19.35 for the creosoted roofers. The extra cost of erecting the treated purlins was little if any. Some of this extra cost could have been saved had time for thorough drying after treatment been allowed.

The ceiling was not painted. Creosoted wood cannot be painted. The resulting dark brown color was not displeasing to the eye nor did it materially lessen the light.

Costs—The following figures are taken from the records and indicate the expense and the details that must be anticipated and watched to keep down costs.

TABLE I. MATERIAL, LABOR, EQUIPMENT AND MISCELLANEOUS

Preservative, 7070.5 gal. of creosote oil	$3,332.39
Freight	169.44
Building small tank (discarded)	103.50
Iron racks for dipping lumber	26.10
Lumber for large tank	100.35
Labor for building large tank (half at double wage)	56.37
Steam coils for large tank	119.98
Metal lining for large tank (emergency sub-contract)	190.56
Steam line connecting tank with mill (including coils for small tank)	84.26
Grating over steam coils in large tank	42.40
Material for draining platform	22.51
Material for cover for large tank	44.02
Hauling and erecting derrick	49.20
Rental on derrick (40 days)	50.00
Labor for treating planks and purlins	2,083.00
Experiments	55.10
Incidentals: nails, gloves and expense account	52.11
Contributions for damage to clothes of workmen	90.00
Involuntary bonus for workmen	90.00
Additional cost of laying treated roof planks	654.31
Overhead and insurance	444.95
Steam furnished by owner gratis	.....
Total gross cost	$7,860.55
CREDITS	
Preservative remaining on hand, 840 gal. creosote oil	$400.00
Sale of empty barrels	200.00
Salvage of lumber from tanks, piping, etc	100.00
Total credits	$700.00
Net cost of treatment	$7,160.55

TABLE II.

COST COMPARISON OF TREATED AND UNTREATED ROOFS

Labor and materials	With Creosoted Deck	With Untreated Deck
Purlins (25,250 ft. b.m. at $115 per M)	$3,019	$3,019
Roofing planks, (79,600 ft. b.m. at $90 per M)	7,164	7,164
Creosoting lumber	7,161	.....
Painting (27,000 squares at 5c.	.....	1,350
Roofing (216 squares at $16.90)	3,650	3,650
Contractor's profit, approximately 10%	2,100	1,518
Total cost	$23,094	$16,701

The contractor on the work was the H. K. Ferguson Co., Cleveland, Ohio; for which T. H. Birmingham was superintendent. The wood preservation engineer was Kurt C. Barth of the Barrett Co. The author acted as engineer for the A. P. W. Paper Co.

Industrial Sidings That Impede Grade Separation

How Litigation and Waste Result from Failure to Provide for Future Grade Changes—Detroit Tackles Problem

PROGRESS in carrying on grade crossing elimination in Detroit has been much complicated by the interference of industrial railroad connections that have been installed without regard to the possibility of later changes in the grade of the railroad line. So many difficulties have arisen that John W. Reid, engineer of grade separation in the department of public works has suggested the adoption of general plans and profiles for all railroads and intersecting streets. If this can be done it will fix future railroad conditions sufficiently to admit of systematic and co-ordinated railroad, industrial and civic development. Occasional amendments may be necessary to meet changed conditions, but in the main the plans would be permanent. Such a definite and permanent condition would evidently be to the advantage of both the railroads and the property development, and consequently to the city as a whole.

Special privileges for laying sidetracks across public streets at grade in order to obtain railroad connection, are frequently granted to industries by city authorities and are likely to cause future complications. Although these grants are usually temporary and revocable, their holders are prone to regard them as conferring permanent rights and to claim damages when separation of grades comes to be considered. Mr. Reid's opinion is that such grants are reasonable, but that the public should not be taxed for necessary interference with the grants, even though such interference should result unfavorably to their holders.

That industrial concerns sometimes fail to recognize the superiority of public rights in such a situation is indicated by the two examples that follow. In the first case the owner had a tract of land without railroad frontage located on a street where the grades have now been separated. Before the separation he had obtained railroad connections by means of a permit from the city to build a sidetrack across this street at grade. This special privilege broadened the usefulness of his property and consequently enhanced its value. To retain these railroad facilities after grade separation, it became necessary to construct a bridge over the street. The city council granted this privilege. Now the owner asks the city to make good to him the cost of this bridge as an item of the damage he claims to have suffered as a result of the public necessity for a change in street conditions that happens to involve his special sidetrack privilege.

In the second case, the property has about 600 ft. of frontage on the railroad and fronts on two streets in which grade separation is in progress. Sidetrack facilities could be obtained within the limits of this property, and before the separation of grades the owner's sidetracks crossed the streets at grade. One of the tracks led off from tracks on railroad property (not right-of-way or yard) located on the opposite side of the street. This particular track arrangement was made possible only through a permit to build a track across the street. Changes due to grade separation necessitate his either abandoning the present track layout or building a bridge across the street at a cost of about

$20,000. The owner has now filed a bill to restrain the city from further prosecution of the work pending determination of the question as to who shall pay for the bridge. His claim is based on the damage done to his property as a result of changing street conditions in such a way as to interfere with the revocable privilege he enjoyed.

In presenting this subject at a meeting of manufacturers, Mr. Reid explained the situation as follows:

Industries sometimes do things that seem difficult to explain. Witness the situation which has been created adjacent to the Detroit Terminal R.R., between Jefferson and Mack Aves. and Hart and Connors Aves. The congested industrial condition there is already serious. With three east and west streets, (Kercheval, Waterloo and Charlevoix) crossed by the main tracks of this railroad and several sidings, and with constantly increasing train and switching movements, it is difficult to see how the public interest is going to be met when the city is built up to the east of this district.

During the past three years plant investments running into millions have been made in that district without any thought of physical conditions ever being disturbed, although it has been evident that such change or disturbance must come in the near future. When this location is considered with reference to the city's railroad gateway at the extreme southwestern end of the city, ten or twelve miles distant, this choice of location is difficult to explain. Is there any consideration due the public interest in the matter of locating industries? Does this sort of thing have any bearing on the question of a fair division of grade separation costs and the measure of damages to be fixed? There are those who claim that damages paid should include some portion of the cost of plant re-adjustment to the new or changed railroad conditions, in addition to the damages resulting from changes in the grade of the street.

Another tendency that is quite commonly met with is that of compromising a plan of grade separation to meet some particular industry's condtions. Within certain limits this may be necessary but it never should be done to the detriment of the general public good. It should be kept in mind that the city is a permanent institution in a sense that permanence cannot be attributed to industries or commercial interprises or even to a railroad. Saying this does no violence to the fact that society, or the city, is dependent largely on both of the latter agencies. Because of this greater permanence of the city, and in spite of this dependence, no plan for grade separation should be determined upon by giving undue weight to present railroad or industrial interests, as against what fairly appears to be the best public interest.

The longer these improvements are deferred the greater the problem to all interests: public, railroad, and manufacturer. Railroad roundhouses will continue to be located as was the Wabash R.R. roundhouse at Harbaugh Ave., just west of an important street. Certain streets were vacated and it was agreed that grade separation would not be required for ten years. This time limit has expired, but the railroad now wants a grade separation plan suited to the roundhouse location, regardless of the effect which such a plan would have on the city streets. Team track yards will be set down across newly opened streets, as was done at the Farnsworth Ave. yard of the Grand Trunk R.R. Or an industrial railway line extension may be thrown across 15 streets and 14 public alleys, as was done in the case of the extension of the Detroit Belt Line from Harper Ave. north to a connection with the Michigan Central R.R. and the Detroit Terminal R.R.

Frequent requests are being made of the city council by adjoining owners for grants of sidetrack privileges and the closing of alleys. In granting such privileges the city is put in the position of assisting to create conditions that must soon be involved in grade separation. Acts like those mentioned must be kept in mind when considering the question of: "What is a fair division of the cost of grade separation as between the railroads and the city?"

Tests of Twelve Large Columns

RESULTS of failure tests on twelve large riveted steel columns, carried out at the Lichterfelde government testing laboratory near Berlin, are reported by F. Voss in "Der Bauingenieur" of Jan. 15. The purpose of the tests was to give a guide in the design of new large bridges over the Kiel canal; eight of the columns were paid for by the canal administration, and four additional ones were supplied by the Deutsche Eisenbauverband, a fabricators' association.

A summary of the column forms and sizes tested, and their results, is given in the attached table. Five of the columns were tested in duplicate. In the case of four of these, the agreement of the two separate tests is very close. Column VII shows a large difference, but here the two specimens were not precise duplicates. The batten plates in the first were 9½ in. wide and had two rivets in each angle, while those of the second column were 14 in. wide and had three rivets; shearing of the batten-plate rivets of the first column limited its capacity.

It was aimed to get a check on the suitability of the column formula and the detail design practice adopted for the design of the canal bridges. The formula $14{,}200(1 - 0.00005\, l^2/r^2)$ was used for lengths up to about 78 radii, and the Euler formula with a factor of safety of 5 for greater lengths. Latticing was proportioned for a shear of 1 per cent of the column load; for columns as heavy as the test specimens it was required to be made of angles. A diaphragm was provided near the ends of the test columns, but two sets of columns were provided also with additional diaphragms. The value of a central longitudinal diaphragm was to be investigated as such construction has been adopted for the canal bridges for members exceeding about 440 tons total stress.

Two columns, I and II, were built to throw light on the latter point, Col. I without central web and Col. II with central web. Other columns were designed for the same load (392 tons) and of the same length (37 ft.) but with various details modified. Col. III was built with a central web like II, but with the latticing on the outer faces replaced by battens and transverse diaphragms. Cols. IV and V were made two-rib columns, similar to I, but with additional transverse diaphragms, the two columns differing only in their rivet spacing (7 in. for Col. IV, 5¾ in. for Col. V). Col. VI, also similar to I, had the transverse struts omitted from the latticing, while Col. VII was fitted with battens in place of the lattice, the battens being respectively two-rivet and three-rivet plates in the two specimens of this column.

While all the material was accepted on mill test (specified qualities, 53,000 to 63,000 lb. per square inch ultimate strength, 20 per cent elongation), the subsequent check tests on waste ends of the plates and angles revealed a large variation of the yield point, from 29,500 in the plates of Cols. I to III to 45,000 in the angles of Col. VII. Further, the material of lowest yield point had an ultimate strength of only about 47,000 lb., while the material of highest yield point reached nearly 67,000 lb. ultimate at back of angle, with an elongation of 15 per cent, showing that the mill tests had not indicated the properties of the material correctly.

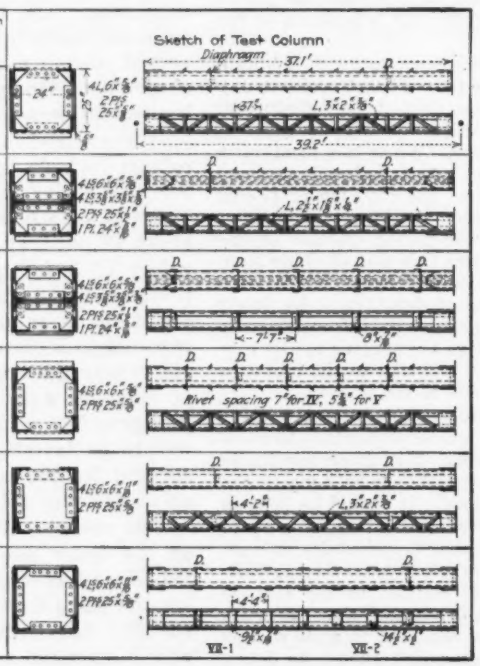
It appeared from the column tests that the ultimate

loads depended on the yield-point strengths of the material. The theoretical capacity of each column was therefore computed (5th column of table) from the tests of the material, the respective areas of angles and plates being multiplied by their yield-point values and the total divided by the total area, to give the average yield-point value in pounds per square inch.

Comparing the fourth and fifth columns of the table, it will be seen that these theoretical capacities agree remarkably well with the test results, except in the case of the first specimen of Col. VII, the one which failed in the batten conditions.

It was deduced from the tests that strong latticing gives the same column capacity as the use of a central web; that the transverse struts in Col. I account for the slight decrease in capacity as compared with Col.

Col. No.	Area of Cross-Section sq. in.	Breaking Load, in 1000-lb. Units	Failure Stress lb./in.²	Average Yield Pt. of Material lb./in.²	Ratio Mat'l. Col.	Length Ratio $\frac{l}{r}$
I-1	63	1965		31,200		51
I-2		1860 Av. 1962	29,500		0.95	
II-1	70	2,300		34,000		56
II-2		2,430 Av. 2,365	33,750		0.99	
III-1	70	2,325		34,000		58
III-2		2,260 Av. 2,293	32,800		0.96	
IV	60	1875	31,400	33,450	0.94	52
V	60	1867	31,250	33,450	0.93	52
VI-1	64	2,330		37,600		51
VI-2		2,395 Av. 2,362	37,100		0.99	
VII-1	64	2,195	34,500	40,500	0.85	51
VII-2		2,445	38,500		0.95	



RECENT TESTS OF LARGE BUILT-UP COLUMNS AT LICHTERFELDE TESTING LABORATORY

VI; that the additional transverse diaphragms and the closer rivet spacing tried out in Cols. IV and V gave no advantage; and that the columns tested, which had length-ratios of 51 to 58, showed no recognizable influence of length-ratio on capacity.

Mr. Voss suggests that column strength appears to be practically constant between length ratios of say 35 and 70, and in this range is equal to the yield point of the material, while above this range the Euler buckling formula begins to become controlling. He also suggests that it is important for proper efficiency to require material of high yield-point strength (34,000 for ordinary bridge steel, and 43,000 for high steel).

Finally, he calls attention to the fact that in spite of the mill-acceptance testing, material of inadequate strength found its way into the test columns, and that better methods of acceptance-testing may be necessary.

Irish Water-Power Resources

By R. Johnstone Taylor
Underdale, Shrewsbury, England

The English Board of Trade has recently issued an interesting report on the water-power possibilities of Ireland. The report points out that there are available 500,000 hp., all capable of economical development. The report goes on to show the comparative cost of coal and other details and give hydrographs of the principal rivers. The falls though low appear well worth developing, but the committee seems to have ignored the large rise of the tail water that the writer knows from personal observation is bound to occur in flood tide.

High falls are available in the mountains of Kerry, Wicklow and Donegal. They are not very extensive, but are well worth development for factory uses. High falls obtained by dams, long supply canals, and other artificial means do not appear to be commercially possible in Ireland. Apart, therefore, from these high-level lakes and possibly some tidal power, the large rivers are the main sources of energy. They would be developed as low-head plants.

Of these rivers, the Shannon, Erne, Bann, and Liffey have been reported on by the committee and suggested as ready for development, but it is rightly pointed out that an organized system of rainfall recording is desirable throughout the country for the purpose of obtaining more reliable data. It is noted that there are no data at all on evaporation, which is assumed as being at 16 in. per year.

Other rivers such as the Lee, Blackwater, etc., have not been investigated in detail, but they appear to be worth investigation. It is suggested that the water power could be sold at a profit of one penny (2c.) per unit. At present there is no public power supply in Ireland which sells under twopence (4c.) per unit.

The proposal to utilize the power of the Shannon River is no new idea. A syndicate was formed in 1901, but went out of business without doing anything, the restrictions by vested interests being too strong. The river has for several years been carefully studied and appears to offer a favorable opportunity as a supply to the midlands with ample power at a cheap rate. Coupled with this is the possibility of river transport. It is suggested that there could be four power stations of a total output of 66,000 hp. which would cost £43 per horsepower. The River Erne developed on similar lines would supply 71,000 hp. and at £29 per horsepower, and the Bann 12,000 at £62 per horsepower.

Water-Works Field Surveyed from Many Viewpoints

Abstracts of Paper and Reports Before
American Water Works Association

The Water-Works Superintendent—Presidential Address

By Dr. Edward Bartow
Head Department of Chemistry, State University of Iowa, Iowa City

SUPERINTENDENTS of large plants must have many assistants and their work must be primarily that of executives. They must rely on specialists to take immediate charge of the various divisions. Superintendents of small plants must take responsibilities for all kinds of work. The duties of the superintendent's office of the large water-works include divisions of engineering, records and revenue. These may be subdivided into receipt and storage of supplies, pumping, purification and quality control, distribution, extension of system, repairs, maintenance, service connections, meters, accounts, revenue control, applications, extension of customers, consumer's accounts, collection of rentals, information, complaints and purchases. Of primary importance is a complete record of all constructions and all installations.

The superintendent must maintain co-operation between the water department and the fire department. The fire department is responsible for the extinguishing of fires but is powerless without an abundant supply of water.

Public Relations—In his relations with the public the superintendent must be a diplomat. Nothing should be done, no action taken, that will offend the public, who are directly or undirectly his employers. He must at all times be courteous, and moreover make his assistants courteous. He must see the viewpoint of the other fellows and when complaints are made do his utmost to remedy any ills, whether real or imaginary. In order to have satisfactory relations with the public, the relations of the employer and employees must be most cordial and there should be mutual confidence. The superintendent must enforce discipline but in a fair and reasonable manner.

The superintendent should be a member of the local chamber of commerce or commercial club and take part in work for civic improvements. He should be a member of local associations where he can show interest in the welfare of the community. He should become identified with state or national water-works associations, and should receive the support of his trustees or board in attending these meetings and should, wherever possible, see that the board members attend the convention also. The underwriters in their reports on management of water companies always note whether the manager is connected with water-works associations. Such connection is an indication of a progressive spirit. The intercourse with other superintendents at meetings and the perusal of the proceedings of the association keep the superintendent out of a rut.

Superintendents Should Be Well Paid—The man who undertakes the responsibilities herein outlined should be well paid. A city should not employ a superintendent because he will work more cheaply than someone else who is more competent. Training and experience should determine a man's qualifications and then the salary should be made to fit the position.

Every well-planned, well-run water-works is a monument to the man who successfully constructed and operated it. I know of but one statue erected in honor of a water-works builder, that for D'Arcy at Dijon, France. In that city grateful people have erected a statue and dedicated a park to the honor of the water-works builder. Though such special cases may be rare, yet in every community where a successful water supply has been obtained and operated, it serves as a monument to the faithful builder and operator.

Twenty Years' Filtration Practice at Albany, N. Y.

By G. E. Willcomb
Supervising Chemist, Division of Water and Sewage Treatment, Albany, N. Y.

DURING the 22 years of operation of the Albany filters, four distinct epochs are clearly marked: (1) The slow sand period from 1899 to 1908; (2) double filtration, commencing with 1908; (3) the introduction of chlorination in 1909 with the subsequent tendency towards decreased filter efficiency; and (4) finally the employment of coagulation followed by the by-passing of the preliminary filter effluent around the slow sand units. These successive steps, from the standpoint of pure filtration, might be considered to be retrogression; but when looked at with a full understanding of the conditions, they are logical enough.

For ten years the plant was operated as a slow sand filter and furnished approximately two thirds of the water required by the city. In 1908 the decision was made to filter enough water to supply the entire needs of the city. Experiments indicated that preliminary filtration would double the output of the original eight slow sand filters at a minimum of expense. After a few years of operation, organic penetration into both preliminary and slow sand units became very marked. The preliminary filters had to begin supplemental washes by ejecting all sand outside the beds, once or twice a year; and the slow sand beds had to have the top 10 to 18 in. of the sand ejected and replaced every other year. It became most difficult to regulate the beds such that not more than one would reach a 4-ft. loss of head at one time. At times during the winter months, six filters would go out of commission at a time, necessitating taking large amounts of gravity water of doubtful sanitary quality to make up the deficit. With the introduction of chlorination and coagulation, water from the preliminary filters became available. As the ultimate capacity of these filters was approximately 40 m.g.d. ample water was at hand at all times for by-passing.

Before the resort was made to by-passing, everything that was practicable was attempted with the slow sand beds to keep the sand free of subsurface clogging and the filters in operation. The beds were forked once a year. The Brooklyn method of surface washing was experimented with. The Nichols method of sand washing was introduced. Varying rates were tried and extra heavy scrapings taken off. But all of these efforts failed to keep the beds in a normal condition until finally the emergency became so acute as to necessitate by-passing immediately.

It will be seen that what really has happened, has been the gradual change of the slow sand process into the rapid sand type. All of the steps have been logical ones based upon economy and expediency. The introduction of the scrubber units became the potential source of a much larger supply of water. The slow sand units, due to outside conditions, eventually became unable to furnish all the water required. The preliminary filters stepped into the breach, and by means of coagulation and chlorination, not only were able to make up the deficit, but were also capable of furnishing a much more attractive water in addition.

As to the future, it is very likely that changes will be made to the basin and to the rapid filters such that they will become typical mechanical filters. This can be accomplished at a reasonable cost and then the money now expended for labor in connection with the operation of the slow sand filters will be saved.

Today, after nearly 23 years' use, the physical condition of the slow sand plant is excellent and stands as a monument to its designer.

The Improved Financial Condition of Water-Works

BY LEONARD METCALF
Of Metcalf and Eddy, Consulting Engineers, Boston, Mass.

Data have been submitted to this association at previous conventions to show the effect upon the expenses and net revenues of water-works in the United States, of the higher costs and lesser efficiencies resulting from war conditions. Data for the years 1920 and 1921 considered in this paper are based on the records of about 45 plants, both publicly and privately owned, serving a gross population of 9,000,000 in the year 1920.

The records indicate that, speaking in general terms, the water-works of the country are past the period of acute distress due to the war, and that their revenues available for depreciation, interest, dividends and surplus, are approaching what would have constituted a normal basis *under pre-war conditions*, but they have not yet reached the higher level corresponding to post-war conditions, nor have they been permitted to make good the cumulative losses of the war period, nor has it been possible for them to make the deferred betterments to meet adequately the growing demands of the service. The results accomplished have been attained in part by increasing the rates charged customers, in part by natural growth, in part by increasing efficiency and decreasing cost of operation as the effects of the war have been gradually overcome, and in part by deferred maintenance and deferred betterments, and an undesirable reduction in margins of safety.

The accompanying table shows the cost of unskilled labor and of materials used in the construction, maintenance and operation of water-works from 1915 to 1921. The cost of contract labor, such as ordinarily used in construction, was of course much higher during the war period than that of the permanently employed labor used in maintenance and operation. It is to be borne in mind, too, that the maximum reduction in efficiency was probably at least 50 per cent at the peak or worst period.

* * *

Cast-Iron Pipe Prices—Two years ago, prices of cast-iron pipe were practically three times normal pre-war prices. In 1920 they rose somewhat further. The average for 1921 was a little more than twice pre-war prices, and at the present time the price is probably a little less than twice that which prevailed before the war. It appears to be abnormally high still and out of line with pig-iron and steel prices and with the price level of other manufactured products as well as of labor, seriously retarding the betterment of water works. Valves and hydrant prices never reached so high a plane during the war as that of other materials, and the fluctuations here were much less marked than in th ecase of cast-iron pipe.

* * *

COST OF UNSKILLED LABOR AND MATERIALS TO WATER-WORKS IN THE UNITED STATES, 1915-21

Item	Number Years	Prices per Unit 1915	1916	1917	1918	1919	1920	1921	Per Cent. Increase Over 1915 (Pre-war Basis) 1916	1917	1918	1919	1920	1921
Unskilled labor, cents per hour:														
(a) Eastern Group	15–18	23.0	26.7	30.4	40.2	43.8	52.5	43.4	16	32	75	91	128	87
(b) Central Group	17–12	21.7	25.3	26.9	37.2	36.8	47.1	40.9	17	24	71	70	117	88
(c) Southern Group	6–12	17.9	20.6	24.5	34.3	34.4	42.1	35.7	15	37	92	92	135	99
(d) Western Group	7– 8	27.0	28.5	31.4	41.8	46.4	54.7	53.5	5	16	55	72	105	98
(e) Average		22.4	25.3	28.3	38.4	40.4	50.0	43.5	13	27	71	80	123	94
Cast-Iron Pipe per 2,000 lb., approx.	17–44	$24.23	$30.70	$51.60	$67.74	$69.20	*76.53	52.30	27	113	179	184	216	116
6-in. valves	11–40	11.18	12.64	19.13	19.13	20.73	24.72	21.93	13	71	71	85	121	96
12-in. valves	3–38	34.78	41.53	65.22	65.02	59.66	68.90	62.13	19	88	87	72	98	79
2-way hydrants	6–38	26.69	32.04	43.13	51.80	47.16	52.30	47.10	20	62	94	77	96	77
Coal per 2,000 lb.:														
(a) Eastern Group	13–15	$2.98	$3.80	$5.96	$6.00	$5.41	7.34	5.81	27	100	101	82	146	95
(b) Central Group	8–12	2.41	2.77	3.75	4.53	4.55	5.84	5.69	15	56	88	89	142	136
(c) Southern Group	7–12	1.92	2.01	3.03	3.89	3.78	5.35	4.45	5	58	102	97	179	132
(d) Western Group**	5– 4	3.97	4.37	6.31	7.92	4.70	5.60	5.29	10	59	99	18**	41	33
(e) Average of Groups		$2.82	$3.24	$4.77	$5.57	$4.61	$6.22	$5.43	15	69	97	63	121	92
Fuel oil, cents per gal., South	1– 3	1.80	1.80	2.00	4.28	.....	2.35	2.93	0	11	138	...	30	62
West	1– 4	1.38	1.50	2.57	4.05	4.09	4.16	4.16	9	86	193	197	201	201
Alum, per lb.:														
(a) Eastern Group		1.12	1.72	1.48	1.45	1.66	1.90	1.75	54	33	29	48	69	57
(b) Central Group		.91	.91	1.25	1.50	1.40	2.66	1.86	0	37	65	54	192	104
(c) Southern Group		1.08	1.38	1.48	1.78	1.56	2.17	1.81	28	37	65	44	101	67
(d) Western Group		1.14	1.21	1.51	1.53	1.79	2.04	2.23	6	32	34	57	79	96
(e) Average		*.06	1.30	1.43	1.56	1.60	2.21	1.84	22	35	47	51	108	73

* Range $50.60 to $83.50 per ton.
** Small number makes record of doubtful value.

Chlorination Before Filtration

BY NORMAN J. HOWARD
Bacteriologist in Charge Filtration Plant Laboratory, Toronto, Ont.

TO FACILITATE operating conditions, increase output, and reduce operating cost, chlorination before filtration was successfully used with the drifting-sand filters of the water-works of Toronto, Ont., during the past year. The chlorine was employed merely as a substitute for alum, leaving disinfection to be done after filtration.

Increasing water pollution at Toronto had made it necessary to raise the alumina from 1 grain per Imperial gallon, for which the plant was designed, to as much as 2½ grains at times. The water contains little turbidity except at storm periods, at which times alum was employed in 1921.

Bacterial results with chlorination before filtration compared with those given by alum, making allowance for the fact that when alum was used the water was at its worst stages, show that pre-chlorination was more efficient than alum treatment. In 1920, when alum only was used before filtration, the cost for chemicals was $60,963. In 1921, alum, for use only when the water was turbid, cost $18,155; chlorme, $2,343; extra labor, $5,975; total, $26,473, or a saving of $34,489. To this should be added a saving in filtermen on other work when not chlorinating, the two making wash water and also a credit for the use of the extra chlorine some $5,000, or a total of $35,490 from prechlorination. No trouble was experienced from tastes and odors due to prechlorination.

* * *

Tastes and Odors and Other Papers on Quality of Water

Chlorination Control By Excess Chlorine Method—Recent New York City practice in controlling the amount of chlorine used was reviewed by Dr. Frank E. Hale, New York City. In July, 1921, the Wolman excess-chlorine [or residual chlorine] method was adopted. Since then, B. Coli have been absent at all four of the city's main chlorination plants except for two determinations. The average dosage was increased from 0.08 to 0.27, taking periods of about 24 weeks each before and after the change. The additional cost of chlorine for treating some 650 m.g.d. was about $30,000. The increased dosage requires increased care to prevent tastes and odors. It is possible that chlorine will

be substituted for copper sulphate to prevent trouble from algae growths. The excess chlorine seemed to have no marked effect on the typhoid curve in 1921 but for the first quarter of 1922 there was a drop compared with 1921 which may be due at least in part to increased activities of the health department as regards oysters, food handlers and the retest of persons who have had typhoid fever. In 1921, 24 new typhoid carriers were found, as compared with 3 or 4 for earlier years.

Recent Chlorination Developments—The outstanding feature of the year in this field, said W. J. Orchard, of Wallace & Tiernan, was the control of Synura and other taste producing organisms in the New York water supply by the excess-chlorine method. [This was also touched upon by Dr. Hale and reviewed by W. W. Brush in a separate paper.] Recently chlorine has been used at Champaign and one or two other places to control chenothrix. In the past two years injectors have been installed in a number of instances for introducing chlorine to water under pressure—notably at the Chicago water-works. These has been successful where the chlorine pressure was three times that of the water. Swimming pool disinfection with chlorine is rapidly increasing.

Water Softening by Base Exchange—Experimental data from a laboratory study of the various zeolites on the market were reported by Dr. Edward Bartow and Gerald C. Baker, In the discussion, point was made of the fact that the nominal zero hardness is really 3 to 5 p.p.m.

Effect of Oil Refinery Wastes on East Chicago Filters—H. E. Jordan said that at both East Chicago and Whiting, oil refineries discharge large quantities of oil wastes into Lake Michigan. In summer, little odor is caused, but the odor increases with cold weather and is at its worst when ice forms. Five bills for the control of oil waste discharges are now before Congress; also a bill or resolution providing for an international investigation of the subject. The matter is of enough importance to be taken up by the government in connection with rivers and harbors. A member from Chester, Pa., reported that experiments on the removal of oil odors by nozzle aeration are proposed there. Paul Hansen stated that small-scale experiments with Spraco nozzles had shown considerable removal of oil odors.

Tastes and Odors from Organic Matters—Studies of the river supplies of Cincinnati, Columbus and Toledo, Ohio, from the viewpoint of odors caused by the decomposition and putrèfaction of organic matters, were summarized by F. H. Waring, of the Engineering Division of the Ohio Department of Health. A rise in the Ohio River at the Cincinnati intake is likely to be followed by tastes and odors but there have been few complaints from this cause. There is a close relation between river stage, turbidity and oxygen consumed, all of which go up, while dissolved oxygen falls. At Columbus, tastes and odors generally go up and down with the Scioto River stages, but rarely is there an accompanying disagreeable taste from decomposition—perhaps because of storage and aeration. Lately the alum dose has been increased in flood time to control the earthy taste in the Columbus water. The Maumee River supply of Toledo has given much trouble from tastes and odors and has been the subject of several expert reports from 1912 on. Conditions are particularly bad when the river is low and icebound. Aeration has been advised but not adopted. Apparently both aeration and coagulation are needed—the latter to remove organic matter.

Discussion: Charles P. Hoover, Columbus, Ohio, said there have been four floods in the Scioto River since Jan. 1. Excess-alum, once at the rate of 12 grains a gallon, has been used to get a "white" water without an earthy taste. G. E. Willcomb, Albany, N. Y., stated that although the Hudson River above the Albany intake receives the sewage from 300,000 people, 125,000 of whom are only ten miles distant, yet there has never been a characteristic sewage odor in the slow sand filter effluent. Prof. C. G. Hyde, of Berkeley, Cal., remarked that practically all the reservoirs below 6,000 ft. elevation in California sometimes have algae growths and require treatment. Algae control is of great importance in climates like California.

Topical Discussions and Other Features of Superintendents' Day

TWENTY-TWO subjects for topical discussion, some with a number of sub-heads and other suggestions, were sent to members prior to the convention and given space on the program for Superintendents' Day. Half or more of these brought no response and some of the others little or nothing of significance. As usual, substitutes for lead as a jointing material resulted in a spirited discussion, chiefly on leadite and for the most part favorable to that material, both as to tightness and money saved.

Much interest was shown in a special seal designed to prevent tampering with water meters but not always proof against water thieves, at least in New York City. The seal is made by the International Seal & Nut Co. As to who should pay for service connections, there were some strong expressions of opinion that not only the service all the way to the meter but also the meter should be put in place and paid for by the water department or company. The disinfection of new water mains before being put into use seemed to be considered as standard practice, or one that should be made such. W. W. Brush said this has been done in New York City for 10 or 15 years past. Chloride of lime at about double the usual rate for ordinary water chlorination is introduced in the new pipe. After the water has been blown out, the pipe is refilled and the water tested. If coli are found, the disinfection is repeated.

Water Chlorination Control in Virginia—The use of a simple outfit for making the orthotolidine test for chlorine was demonstrated by L. N. Enslow, of the Virginia State Board of Health. The outfits are mailed to water-works needing them. They include standard color solutions to indicate 0.2 and 0.8 doses of chlorine; a bottle of orthotolidine; an empty bottle for the water to be tested; a dropper; and directions for use.

Cause of Failure in Cast-Iron Pipe—F. A. McInnes, Boston, stated that of 19 failures in 16 to 48-in. cast-iron pipe in Boston during the past 12 years, 9 were due to settlement at points of unyielding supports introduced after the pipe was laid; 3 to blasting; 2 each to freezing and bad ground; 1 to imperfections; and 2 unexplained.

Maintenance and Shop Equipment at Rochester—George E. Cripps, superintendent of water-works repairs at Rochester, N. Y., recounted some of his experiences of the past 38 years. From small and crude equipment, the city has advanced to 26 automobiles and trucks and a large meter and general repair shop. A boiler mounted on a truck has proved very useful in thawing away snow and ice over gate boxes and in assisting the fire department in cold weather. A valve-opening and -closing machine, mounted on a truck, saves time and money. One piece of shop equipment is a home-made device for holding and welding hydrants broken by automobiles. Acetylene burners are used for cutting large mains.

Purification of Water for Industrial Purposes—A detailed review of water treatment for a variety of industrial purposes was presented by S. T. Powell, of Baltimore. The Consolidated Gas, Electric Light & Power Co. of the city named has installed settling basins and filters to treat water for its boilers—or rather for the 10 per cent of "make up" water required to supply the loss in condensation and re-use. Water softening is on the increase. Zeolite, first used for laundry waters, is coming into use for power plants, but it cannot be used for turbid waters or for very hard waters unless they are previously treated. Degassing to prevent corrosion is receiving attention. Robert S. Weston, in commenting on this paper, expressed the opinion that it was unequalled in our language. A separate paper on zeolite for water softening was read by A. S. Behrman, who also reviewed the use of lime and soda-ash as an alternative. The latter has the advantage of not requiring removal of turbidity and of causing less loss of head.

Turbo-Centrifugal Pumps—Richard Waller presented a paper in which he expressed the belief that money would be saved if 75 per cent of the triple-expansion pumps were replaced by turbo-centrifugal. He thought the life of the latter had been overestimated.

Reports of Council on Standardization and Some of its Sub-Committees

Council on Standardization—The committee expects each of its 17 sub-committees to submit to it a quarterly report. It is intended that such parts of these reports as are approved by the council will be summarized in the *Journal*. A committee on steel pipe has been formed. Eight committees submit progress reports to the 1922 convention.—George W. Fuller, chairman.

Industrial Wastes in Relation to Water Supply—Questionnaires have enabled the committee to make a list of 248 water supplies, located in 25 states and provinces, affected by industrial wastes. The chief causes of pollution are: Coal mining (washery and acid mine drainage), 107; coal distillation (gas and coke making), 48; metal pickling and galvanizing, 14; chemical (acid wastes), 9; oil wells, 9; pulp mills, 9; oil refining (oil wastes), 7; tanneries, 7; sawmills (sawdust), 6. Methods of attacking the various wastes are: (1) treating the polluted water; (2) treating the wastes before discharge (3) eliminating the wastes from sources of water supply. Control, by reasonable methods, should be vested in state boards of health, provided with ample authority and with adequate appropriations for field and laboratory work. In many states existing policies should be broadened. The Federal Government should assist in the case of interstate and widespread problems—Almon L. Fales, chairman.

Watershed Protection — [Portions only of conclusions under ten heads]. The committee as a whole is of the opinion that it is hopeless to undertake a standardization of the basic (watershed protection) law in the several states, although it has been brought home to more than one member that this variation in fundamental legislation has worked, and probably will in the future, to the disadvantage of public water supplies.

Under water-borne diseases, the committee is in agreement that for populated watersheds the usual precautions taken by health authorities for the control of sources of infection may properly be supplemented by additional safeguards, to be undertaken by the water-works management, in the direction of early identification of the diseases, through disinfection during illness and convalescence and a "follow up" designed to keep track of such cases as may develop into carriers.

Except where the supply is drawn from a river of some size the committee membership is in general agreement that ownership of marginal strips about reservoirs and along principal streams, particularly in the vicinity of the intake, is desirable as one of the means of maintaining a safe water supply, even though such marginal areas are relatively so small that the waters may not be safely used without purification. Such areas should be at least sufficient to preclude bathing, boating, fishing and ice cutting in the vicinity of the intake and, dependng upon relative costs of land and purification, such areas should be extended to the utmost that the economics of the particular case warrant.

The crux of the whole matter of watershed protection is so to operate and maintain the entire collecting system that the amount of pollution reaching the reservoir, or reservoirs, is reduced to a minimum, thereby lessening to the utmost the load to be carried by that great purifying agent—storage. When success attends this undertaking, even under adverse climatic and stream flow conditions, the problem of a clean surface water has been solved. When, under these adverse conditions, doubt exists as to the outcome, the practices here outlined should be supplemented, not supplanted, by an appropriate purification process.—Theodore De L. Coffin, chairman.

Standard Form of Contract—The committee submits for printing in the *Journal* and for discussion a universal agreement (already printed by other societies), for use with a few verbal changes, for any kind of construction contract having a provision for arbitration—the particular form submitted having been adapted to railway construction. This form has resulted from conferences of representatives of the American Institute of Architects, American Railway Engineering Association, Associated General Contractors, American Society of Civil Egineers, Engineering Council, and other organizations, including the American Water Works Association, with the co-operation of Herbert Hoover, Secretary of the Interior. No attempt has yet been made to prepare a universal form of agreement for water-works or any other public works' contracts.—J. Waldo Smith, chairman; John M. Goodell, secretary.

Standard Specifications for Cast-Iron Pipe—No decision has been made as to adopting uniform outside diameters, a point on which the users are about evenly divided while the manufacturers are against the proposal. If centrifugally-cast pipe becomes a commercial success, as now seems likely, then the change may come. The event of the year was the report of Dr. Richard Moldenke on test pieces and other matters. Dr. Moldenke opposes chemical requirements, except as to sulphur. The committee has reached no conclusion on this subject but it is not improbable that it will follow Dr. Moldenke. The manufacturers have agreed to finance additional studies by Dr. Moldenke. Due to lack of funds for the purpose, no progress has been made in the study of pipe coatings. — F. A. Barbour, chairman.

Physical Standards for Distribution Systems—Progress has been made on terminology. Little has been done on hydraulics and economics of the subject. The major function of the committee will probably be to collect and classify data. Feeder mains, secondary feeders, and distributors are suggested as terms for the main pipe system—G. Gale Dixon, chairman. Discussion: Allen Hagen suggested that for "distributors" the committee substitute "reticulation"—the generally used and self-explanatory British term.

Slides in Meter Schedules—The committee submits the tentative recommendation that the American Water Works Association adopt the three-step plan adopted a few years ago by the New England Water Works Association, but with the optional addition of a special rate for very large quantities. The service charge principle should also be endorsed. A broadening of the scope of the committee to include all phases of meter rates is also advised. The committee secured co-operative representation from the New England Association and in addition obtained the views of every member of the former New England Committee (of which Mr. Hazen was chairman). Under the slide plan now proposed, meter charge steps would be (1) the first 25,000, (2) the next 225,000, and (3) all in excess of 250,000 gal. a month; and where a special rate was charged it would be for very large consumption only, the suggested figure being for all in excess of 2,500,000 gal. per month. All these charges are *in addition* to a minimum charge based on the size of meter used.

The three steps or slides already given provide for what are termed domestic, intermediate and wholesale or manufacturing rates. Nothing in the report should be considered as adverse to a no-slide or uniform meter rate, combined with a meter or service charge, where conditions are favorable. A uniform rate would be logical where the cost of water mains are assessed against abutting property owners.

The committee finds that the New England three-step plan (or a similar two- or four-step plan), is already used by the Spring Valley Water Co., and the East Bay City Water Co., California; the Hackensack Water Co., and a number of other companies and cities.—Allen Hazen, chairman; Isaac A. Walker, secretary.

Abstracts—A corps of 19 abstractors has been formed, with Frank Hanna, chemist filtration plant, Toronto, Ont., as abstractor-in-chief. More abstractors are needed. About 75 publications have been selected for abstract. Co-operation with the American Chemical Society has been arranged for. In the January and March issues of the *Journal* there were published 78 abstracts, filling 19 pages.—Almon L. Fales, chairman.

Standard Methods of Water Analyses—Different elements of the existing standards of the American Public Health Association have been assigned to sub-committees for study. These include some matters previously in dispute and some

new points. The committee proposes to add to the procedure for each determination a brief discussion of its significance. Unfortunately it has not yet been possible to effect co-operation with the similar committee of the American Public Health Association.—J. J. Hinman, chairman.

Discussion: Allen Haze, chairman of the Chemical and Bacteriological Section (before which this report and the one on colloids was presented) said that when the revisions and additions to the existing A. P. H. A. standards have been completed he felt that co-operation could be secured since the original A. P. H. A. committee was composed largely of members of the waterworks association. A show of hands indicated that a majority of those in attendance (about 75 at the Chemical and Bacteriological Section were members of the American Public Health Association.

Colloidal Chemistry in Relation to Water Purification—The committee has collected and compiled data on hydrogen-ion determinations from many laboratories. The usefulness of this determination seems to be greater with soft than with hard waters. A definite appraisal of the method cannot yet be made. Laboratories are requested to send the committee all available hydrogen-ion determinations, no matter how meager.—Robert S. Weston, chairman.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

From an Engineer's Wife

Sir—I am not a writer, but I am a civil engineer's wife and take a great interest in the profession. My husband takes *Engineering News-Record* and we find it very helpful and instructive to him as well as interesting to us both. For myself I think engineering is a profession that should be classed among the greatest of professions, but from close observations am forced to the conclusion that in the eyes of the general public it is not appreciated as it should be.

The question is, why? Is this not a very good reason: Every Tom, Dick and Harry that can purchase a pair of khaki trousers, puttees, and carry a transit on his shoulder calls himself a civil engineer? Here are a few instances in my home town. In one of our local papers a few days ago appeared this personal: "Mr. So & So, civil engineer, left this morning for his vacation." Now to my personal knowledge this man carried a chain and drove stakes on an engineering party for six months or a year; previous to this he was a street car conductor. Another man whom I know personally is listed in the City Directory as a civil engineer and posing as such before the public, when he has no more idea of the principals of engineering than my three-year-old boy. True he can wear puttees, carry a transit and set it up and that is about all.

Is this fair to the profession? How much does the world owe to engineers? In the World War who were braver or did more to hasten victory? The formation of engineering societies is a great step in the right direction.

AN ENGINEER'S WIFE.

Map Scales in Practice

Sir—In regard to the scales of the U. S. Geological Survey topographical maps, although there appears no good reason for the adoption of that of 1:62,500, or multiples of that scale, it would seem evident that the scale now in use, so closely representing one mile (or its multiple) to the inch answers well for the non-technical or layman user, and that others who use the maps are very largely those of the engineering profession who make use of them for water power, water supply, irrigation, highway, railroad and other purposes. All of the maps are necessarily on too small scale to take the place of careful surveys where extreme accuracy is required.

For the determination of watershed areas the maps are generally sufficiently accurate for all practical purposes, except that on small watersheds it is necessary to correct the maps for errors that would be immaterial on larger areas. Using the scale of one inch to one mile on the maps engraved to a scale of 1:62,500 requires, for greater accuracy, a deduction of about 1¼ per cent for lineal measurements and about 3 per cent for areas. The results then will be as close as it is possible to work from a map approaching that small scale and especially since these maps are subject to the variable error due to shrinkage. It is well known that old maps show a very marked error by shrinking, and hence it would appear that the present maps should read "Scale 1:62,500 approximately," then, with the accurately drawn graphical scales in miles and kilometers, anyone would be able to work most accurately from the maps regardless of their age.

Without doubt, engineers would prefer the inch-to-the-mile scale, and if the cost of the change would not exceed $100,000, as stated by F. E. Bonner in your issue of April 6 to be a fair estimate, the change would probably meet the approval of a very large majority of all kinds of users of the maps, although for reduction to lineal feet there would be no advantage in multiplying inches of map by 5280 over inches by 5208, as at present.

It is probable that the compilers of automobile route books use these maps to determine distances between different points and very likely assume the maps are on a scale of one inch to the mile, and, if so, with the maps on that scale, the distances in the route books would be more accurate.

It does not seem advisable to consider a change to the metric system. The great value of the maps is that they are contoured. The changing of their horizontal projection by photolithographic process to a metrical scale would leave the contours referred to sea level, so that there would be confusion in that respect. To change the contour lines to the metric system would be so expensive as to be impracticable.

Rochester, N. Y., May 18. CHARLES C. HOPKINS, Consulting Engineer.

Lost Time in Paving Work

Sir—The article by H. K. Davis in *Engineering News-Record*, May 4, p. 720, brings out particularly the following facts:

1. "In ninety-six working days work was done on only seventy-four days, and only fifty-five full days were worked."

2. "If there had been no delays the whole season's work could have been done in two and one-half months." (in other words, work was carried on intermittently and when work was going on it was not always with full capacity).

These facts do not apply to concrete pavement construction alone. The condition is the same with every kind of paving work. Perhaps in some types, like asphaltic pavements, other elements enter in which make the situation worse. I venture the statement (based on twenty years' experience) that there is not a single asphalt paving plant operating in any large city of the United States that could not finish the work done by it in any year in less than ninety days, if the plant was working continuously and working to full capacity.

Such statements make the reader who is interested in paving, either as contractor, taxpayer, or engineer, sit up and take notice. Delay and loss of time mean larger overhead charges and the profit to the contractor either is not as much as it could be or the taxpayer is paying more for the paving than he should pay.

The facts stated in the article suggest the question: What can be done? Is there no way of doing away entirely or at least, partly with these handicaps? The question needs serious consideration. It's answer requires the co-operation of contractors and engineers.

G. G. HEGHINIAN.

Brooklyn, N. Y., May 9.

NEWS OF THE WEEK

New York, May 25, 1922

J. Waldo Smith Resigns as Catskill Aqueduct Chief

Terminates 17 Years Service as Engineering Head of New York Board of Water Supply

After a continuous service of 17 years, during which New York City's 100-mile Catskill aqueduct was designed, constructed and placed in operation, J. Waldo Smith has resigned as chief engineer of the Board of Water Supply in order, as he expresses it in his letter of May 15 to the board, "to lay aside some of the responsibilities that have been carried for many years and to serve in another capacity." Mr. Smith will continue his connection with the Board of Water Supply as consulting engineer, and upon his recommendation Thaddeus Merriman, deputy chief, will succeed him June 1 as chief engineer. "I would not think of taking this step," said Mr. Smith in his letter of resignation, "if there were not others entirely familiar with the work, having a length of service nearly equal to my own who, by experience and ability, are capable of directing the work and unless I had a firm belief that I could be more helpful in an advisory position where I can have a better perspective of the future."

His Early Work

While the Catskill work has been the outstanding feature of Mr. Smith's professional career he has had a long and varied experience in water supply and hydraulic work in the New England States and particularly in New Jersey. He was born in Lincoln, Mass., in 1861 and was graduated from the Massachusetts Institute of Technology in 1887. After a period as assistant to Hiram F. Mills, in Boston, Hamilton Smith, Jr., and Clemens Herschel, in Holyoke he became in 1890 resident engineer for the East Jersey Water Co. on the construction of dams, reservoirs and experiments on gates and 48-in. Venturi meters. In 1897 he was appointed engineer and superintendent of the Passaic Water Co. of Paterson, N. J. and also of the Montclair Water Co. and under his direction the well-known filtration plant at Little Falls, N. J. was designed and built. At that time it was the largest in the United States.

Mr. Smith undertook larger responsibilities in 1903 when he was appointed chief engineer of the Croton Aqueduct Commission, New York City, and during his tenure of that office such well known structures as the Croton Dam, the Cross River Dam, and the Jerome Park reservoir were constructed.

When the Board of Water Supply of the City of New York was organized in 1905 by Mayor McClellan to administer the great Catskill water project, Mr. Smith was appointed chief engineer and he has served in that capacity continuously to date. A detailed account of his administration of the Catskill work was published in *Engineering News-Record* Oct. 11, 1917, on the occa-

J. WALDO SMITH

sion of the official opening of the aqueduct. Under his direction were built structures which have won international reputations, including the Askokan reservoir, the Kensico dam, the Hudson River pressure tunnel 1,100 ft. below the water surface, the 18-mile city aqueduct tunnel, the longest continuous tunnel in the world, and the 18-mile Shandaken tunnel now under construction for the development of the Schoharie watershed.

J. Waldo Smith has received many professional honors. He was elected a director of the American Society of Civil Engineers in 1906, and vice-president in 1913. In 1921 he was a candidate for the presidency of the society but was defeated in a close vote by

(*Continued on p. 888*)

THADDEUS MERRIMAN

Thaddeus Merriman Is Water Board's New Chief Engineer

Thaddeus Merriman, deputy chief engineer, has been appointed chief engineer of the Board of Water Supply of the City of New York, to succeed J. Waldo Smith, whose resignation is noted elsewhere in this issue. Mr. Merriman has served on the engineering staff of the board since 1905, beginning as assistant engineer, with successive promotions to assistant to the chief engineer in 1907, department engineer, headquarters, in 1914, and deputy chief engineer in 1918. He enters upon his new duties with the unqualified endorsement of his former chief. In speaking of his long service and special fitness Mr. Smith said of Mr. Merriman: "In all the positions he has filled he has rendered a high order of service and has displayed unusual ability and good judgment."

Mr. Merriman was born in New Haven, Conn., April 6, 1876, and was graduated from Lehigh University with the degree of civil engineer in 1897. During the summers of his college course he served as rodman with the borough engineer of Bethlehem, Pa., in the drafting office of the Bethlehem Iron Co. as sanitary inspector of the Montclair, N. J. Board of Health, and as rodman and transitman on the Lehigh Valley R.R.

After leaving college he engaged on geological survey and reconnaissonce work in Pennsylvania and then went to New Britain, Conn., as assistant engineer on water supply development.

Served in Nicaragua

For two years, beginning in 1897, he served with the United States Nicaragua Canal Commission and in 1899 became assistant engineer and chief of party on canal surveys in Nicaragua with the U. S. Isthmian Canal Commission. Returning to the United States in 1900 he joined the staff of the New York Continental Jewell Filtration Co. and prepared the designs for the Little Falls, N. J. filtration plant. For a year ending in 1902 he was inspector, in the United States, of bridges, locomotives and railway materials for export to Ecuador for the Guayaquil & Quito Railway Co.

Mr. Merriman's continuous service in the water-works field began in 1902 with the Jersey City Water Supply Co. as assistant engineer on the Boonton, N. J. dam and later as division engineer on completion of work and on general hydraulics and construction for the East Jersey, Passaic and Aquackanonk Water companies, where he served under J. Waldo Smith. Shortly after Mr. Smith became chief engineer on the Catskill Aqueduct Mr. Merriman joined that organization in August, 1905, and served in the several capacities indicated in the earlier part of this article.

Mr. Merriman will assume his new duties as chief engineer on June 1, the date on which Mr. Smith's resignation becomes effective.

U. S. Chamber of Commerce Holds Annual Meeting

Influence of European Conditions On American Business Taken as Theme for Many Discussions

(Engineering News-Record Staff Report)

European conditions and their effect on American business was the keynote of the tenth annual meeting of the Chamber of Commerce of the United States, held at Washington, May 15-18. Special interest attached to this meeting, coming as it did during the final sessions of the Genoa conference. As a result it was the scene of several announcements by government officials concerning the attitude of the United States toward European problems.

On Thursday, President Harding addressed the convention. In describing the work of the Department of State, Secretary Hughes took occasion to lay down principles having a direct bearing on relations between this country and Mexico and Russia. Secretary Hoover outlined the effect of the European situation on American business. As essential steps in the restoration of stability abroad, he laid down the following:

PRINCIPLES FOR STABILIZATION

"First, such political relations between the states in Europe themselves as will produce an atmosphere of peace and destroy the atmosphere of war.

"Second, the reduction of armament not only to lessen government expenditure but to give confidence of peace.

"Third, the inter-governmental debts including German reparations to be fixed upon such a definite basis of payment of interest and principal as will create reasonable confidence that payments will be met.

"Fourth, the balancing of budgets more through the reduction of expenditure than the increase in taxation, and a cessation of the consequent inflation in currency and short-time bills.

"Fifth, the ultimate establishment of the gold standard with the assistance of either credits or gold loans, and where necessary, the acceptance of diminished gold content to many old units of currency.

"There are many less important steps but they become easy and certain when these major issues are accomplished. If these measures could be accomplished tomorrow the stream of commerce and industry would rush economic recovery at a pace which would amaze the world."

At the general sessions, held mornings and evenings, the broad questions of international economics, industry, and finance were considered.

Albert D. Lasker, chairman, U. S. Shipping Board, laid before the convention the president's program for a ship subsidy to aid in the establishment of the American merchant marine and urged its approval by the business men of the United States. The proposal was discussed from the viewpoint of the farmer by Harvey Sconce of Sidell, Ill., from the viewpoint of the ship builder by J. G. Ackerson, vice-president, Merchant Shipbuilding Co., and from the viewpoint of the ship operator by Frank C. Munson, president, Munson Steamship Lines. Mr. Ackerson and Mr. Munson emphasized the growing importance of the Diesel engine in the field of marine engineering.

At the afternoon sessions group conferences considered the details of the specific problems now in the forefront of American business life.

Transportation was considered under three heads: railroads, highway transport and merchant marine. Under the first was considered the experience of the American railroads under the Transportation Act of 1920. The opinion prevailed that the act had not yet had time to demonstrate its wisdom and that no change should be made in it at this time. The highway transport section as noted elsewhere in this issue, discussed the practical regulation of highway transport and the economic foundation for its future progress. At a general meeting on transportation Frederick Delano former president, Wabash R.R. and former member of the Federal Reserve Board, discussed comparative transportation conditions in Europe and America. Dr. R. F. MacElwee, dean, School of Foreign Commerce, Georgetown University, described the European water carriers and set forth their relative function in the transportation scheme, and Col. Clarence B. Smith, U. S. Army, unofficial representative of the United States on the Austrian Section of the Reparations Commission, told of the problem of southeastern Europe and the Portorose conference at which he was American observer.

During the sessions the cornerstone was laid for the new home of the Chamber of Commerce at the corner of Connecticut Ave. and H. St. Julius H. Barnes of Duluth, Minn., was elected president to succeed Joseph H. Defrees of Chicago. Other officers elected were: Vice-president for the Eastern States, A. C. Bedford of New York; for the Northern States, Thomas E. Wilson of Chicago; for the Southern States, Harry Black of Galveston, Tex.; for the Western States, Thomas P. Stearns of Denver. Honorary vice-presidents, William Butterworth of Moline, Ill., L. M. Gillette of Minneapolis.

Engineers on Exposition Committee

Twenty-one members of the Engineers Club of Philadelphia have been appointed to the Committee on Grounds and Buildings for the Sesquicentennial Exposition to be held in that city in 1926. In the committee membership of sixty-six the following is the engineer representation:

Alba B. Johnson, chairman; Samuel Rea, W. F. Ballinger, W. F. Barba, Samuel T. Bodine, Charles E. Brinley, Charles Day, Kern Dodge, W. C. L. Eglin, Benjamin Franklin, Philip H. Gadsden, John Price Jackson, L. H. Kinnard, C. N. Lauer, Joseph B. McCall, John Meigs, Ralph Modjeski, Charles Penrose, E. B. Temple, Samuel T. Wagner and George S. Webster.

State Sanitary Engineers Re-elect Old Officers

At the Conference of State Sanitary Engineers held at Washington, D. C., May 16 and 17, C. A. Emerson, Jr., Harrisburg, Pa., was re-elected chairman; W. H. Dittoe, Columbus, Ohio, vice-chairman; and Theodore Horton, Albany, N. Y., secretary-treasurer. Over twenty representatives of the engineering divisions of the various state departments of health were present.

Water-Works Convention Breaks Records

American Association Hears Fifty Papers and Reports and Holds to Its Schedule

(Engineering News-Record Staff Report)

Besides the large attendance and the extensive display of the Water-Works Manufacturers' Association in unusually attractive and comfortable quarters, features of the convention of the American Water Works Association held last week in the Bellevue-Stratford Hotel, Philadelphia, were eight valuable sub-committee reports resulting from the work of the Council on Standardization, a Manufacturers' evening for the presentation of papers, a successful Superintendents' Day, and crowded meetings of the Chemical and Bacteriological Section, one of which was held jointly with the other members. Fifty papers and committee reports were presented, not counting the topical discussions on Superintendents' Day. From the presidents' address and informal reception Monday evening to late Friday afternoon the only time not devoted to papers and discussions was Wednesday afternoon, when the members and guests enjoyed a boat ride on the Delaware provided by the Manufacturers' Association. The convention was also notable for close adherence to the program.

CLASSIFICATION OF MEMBERSHIP

In his presidential address, abstracted with other papers and committee reports elsewhere in this issue, Lt.-Col. Edward Bartow stated that the association has grown from 349 to 1,608 members in 20 years. Later, Robert Morse, chairman of the Publication Committee, reported that the membership [active only] was divided as follows: Engineers, 569 or 43 per cent; superintendents, 288 or 22 per cent; executives, 248 or 18 per cent; chemists and bacteriologists, 87 or 6 per cent; unclassified, 134 or 10 per cent. Mr. Morse also explained that the program had been made long to afford added information and the convention carried through the whole of Friday to give the chemists and bacteriologists more time than they have had at previous conventions. On the closing day a considerable majority of those voting on the subject declared themselves in favor of two sessions on Friday next year.

The Finance Committee, through George C. Andrews, chairman, reported a good working balance, besides $12,000 in the investment fund. A budget of $20,100 for 1922-3 was proposed and adopted. Of this sum $8,500 is for the *Journal*, $2,500 for committee expenses, and $1,200 for salary of the editor.

A canvass of the ballot for officers disclosed no opposition to the committee nominees. The following were elected: President, W. S. Cramer, Lexington, Ky.; vice-president, George W. Fuller, New York City; treasurer, W. W. Brush, New York City (re-elected); trustees, George W. Batchelder, Worcester, Mass., for District 1, and J. W. Ellms, Cleveland, Ohio, for District 4. Before adjournment, the Executive Committee announced the reappointment of John M. Diven, New York City, as secretary; Abel Wolman, Baltimore, as editor; Robert Morse,

(Continued on p. 887)

Lives Lost in Texas Bridge Wreck

Failure of the Brazos River bridge west of Marlin, Texas, May 16, caused the death of a number of persons who had been standing on the structure when it went down. The river was at flood stage. Repair work was in progress, and several dozen people were watching the work from the deck of the bridge. Details of the cause of the accident are not yet available.

Public Roads Bureau Gets $483,320 by New Act

Congress has finally passed and the President has approved the appropriation bill for the Department of Agriculture for the new fiscal year beginning July 1. For the Bureau of Public Roads the bill makes available $483,320, of which $367,120 is for various investigations and $116,200 for administration.

The appropriations include: $66,800 for investigations of road management and highway construction; $77,060 for investigation of best methods of road making; $175,000 for investigation of chemical and physical character of road materials; and $15,000 for maintenance and repair of experimental highways.

New York Section, Am. Soc. C. E., Elects New Officers

At its annual meeting May 17 the New York Section of the American Society of Civil Engineers elected J. Vipond Davies, consulting engineer, as president. F. C. Noble and Charles W. Leavitt were elected vice-presidents. H. M. Lewis and C. R. Hulsart become secretary and treasurer respectively. The two new directors are W. G. Grove and W. C. Briggs.

Regional planning for the New York district was discussed at the same meeting. The ground covered was similar to that traversed at the special meeting on regional planning of the previous week, reported on p. 842 of last week's issue. The subject was introduced by Charles D. Norton, chairman of the Committee on Plan for New York and Environs of the Russell Sage Foundation. Arthur S. Tuttle, chief engineer of the city's Board of Estimate and Apportionment, described the origin of the present city plan and incidentally defended the Manhattan street plan. H. M. Lewis presented a large collection of maps and diagrams bearing on the growth of the metropolitan district and its present equipment and requirements as to roads, parks, water-supply sources, and sewage disposal plants.

Jay Downer, chief engineer of the Bronx Parkway Commission, outlined the present Westchester outer park system and the enlarged system expected to develop from the connection of Bear Mountain Park and the new Mohansic Lake reservation with the nearly completed Bronx River Parkway under the new Bronx County Park Commission. Morris Sherrerd, of Newark, sketched the change in point of view in New Jersey as to the unit of planning, from city to county and now to something larger than the county. He urged the need of an excess condemnation law for efficient execution of development plans. B. H. Saunders, chairman of the Plan Commission of Paterson, spoke of the efforts now being made to develop that city.

Freight Rates Reduced by Commerce Commission Order

(Washington Correspondence)

Reductions equivalent to 10 per cent on all freight rates were ordered in an opinion handed down by the Interstate Commerce Commission May 24. After considering all the facts of record, including the necessity of expenditures for additions and betterments, the commission found in part:

(1) That on and after March 1, 1922, a fair return upon the aggregate value of the railway property and material defined in Section 15 A of the Interstate Commerce Act, determined as therein provided, will be 5.75 per cent of such aggregate property value as a uniform percentage for all rate groups of territories designated by this commission.

(2) That the existing freight rates and charges, including charges for switching and other accessorial services and all other charges applicable to freight service, which were increased by authority of "Increased Rates, 1920, supra," will be, on and after July 1, 1922, unjust and unreasonable to the extent that they may respectively include more than the following percentages of increase over the rates in effect immediately prior to Aug. 26, 1920, in and between the various rate groups as defined in certain orders:

In the Eastern group, also between points in the Illinois territory and between the Illinois territory and the Eastern group, 26 per cent instead of 40 per cent is authorized in the decision cited.

In the Western group and between the Western group and the Illinois territory, 21.5 per cent instead of 35 per cent so authorized.

In the Southern and Mountain-Pacific groups, 12.5 per cent instead of 25 per cent so authorized.

On inter-territorial traffic, except as provided otherwise, 20 per cent instead of 33⅓ per cent so authorized.

Statute of Limitations Pleaded in Knickerbocker Case

John H. Ford, of the Union Iron Works, Washington, who designed the steelwork of the Knickerbocker Theater roof and was recently indicted for the collapse of the roof on Jan. 28 when 97 persons were killed, has pleaded the statute of limitations against prosecution under the indictment. The theater was built in 1917 and Ford was indicted on April 3, 1922, and he claims that the offense charged did not occur within three years prior to the finding of the indictment. Other objections to the indictment are made in his answer, among them the claim that it fails to charge Ford with a definite individual duty for the neglect of which he is sought to be held responsible, and there are no facts alleged to show that any duty was imposed on him when undertaking his part of the construction work conjointly with the other defendants. It is claimed also that nothing in the indictment shows that there was any duty on Ford either by contract or operation of how to notify and warn any person of the alleged danger of the unsafe condition of the Knickerbocker Theater Building or any neglect of duty in permitting patrons to attend the theater and be in the building at the time of its collapse.

Second Election Required on New Charter for Atlanta

Owing to the lack of a majority for any one of the three charter plans voted on at Atlanta, Ga., May 16, there will be a second election on May 30, on the two plans that got the highest number of votes. The vote May 16 stood (1) 4,095 for amendments to the present charter; (2) 3,335 for a modified type of commission-manager plan; and (3) 2,283 for the federal plan—a clear-cut separation of legislative and administrative functions, except that the council would confirm and could remove by two-thirds vote any one of the five executive department heads appointed by the mayor, while the mayor himself would be subject to recall.

Of the two plans to be voted on again, (1) would amend the present charter by vesting in the council the functions now performed by water, health, park and police boards, but the executive heads, including the city engineer and superintendent of waterworks, would continue to be elected by popular vote. Under (2) a board of aldermen (including the mayor as a member) would appoint a chief administrator, who, according to the proponent of the plan, would have somewhat less power than does the city manager under most of the manager charters.

Contract for Sewage-Works Let at Decatur, Ill.

A coarse screen, a three-compartment grit chamber, six Imhoff primary settling tanks, two dosing tanks with 30-in. siphons for alternate operation, three acres of filter beds 6 ft. thick, a Dorr secondary settling tank, 40,000 sq.ft. of sludge drying beds, a 40-in. Venturi meter, a river outlet, and water-supply and drainage systems are included in the sewage-works for Decatur, Ill., contract for which had been awarded to L. N. Cope & Son, of Decatur, at $567,630. Four other bids ranged from $622,000 to $692,000. The engineer's estimate was $560,000.

The work is to be completed by Dec. 15, 1923. This plant is designed for a population of 60,000 in 1930, except that the filters are considered sufficient for a present population of 45,000 together with a considerable amount of corn-products waste. Space is provided for increasing the filter area to twelve acres. Pearse, Greeley & Hansen, Chicago, are the engineers.

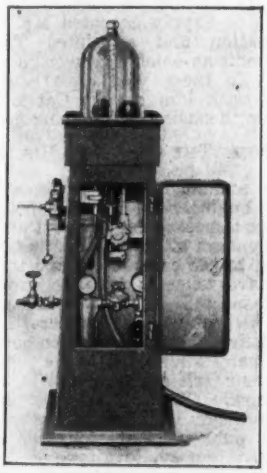
Once More the World's Largest Ship

On May 17 the White Star liner "Majestic," the world's largest ship, reached New York on her maiden voyage. She is 956 ft. long, 100 ft. wide and 102 ft. deep from bridge to keel. Her registered tonnage is 56,000 tons, her displacement 64,000 tons and her oil-burning turbines have 100,000 maximum horsepower, which permit of an average speed of above 25 knots. The loaded draft is given as 41.3 ft. The "Leviathan," formerly the "Vaterland," which has been the largest vessel since before the war, is 950 ft. long, 100.3 ft. wide and is registered at 54,200 tons. The "Majestic" was built in Germany; she was to have been the "Bismarck" but was taken over by the British and completed by the firm of Blohm and Voss to British order.

New Water-Works Equipment Shown at Convention

Among the newer pieces of apparatus in the unusually complete exhibition of water-works machinery and equipment at the Philadelphia convention of the American Water Works Association last week were the following:

A long-distance water-stage recorder manufactured by W. & L. E. Gurley, Troy, N. Y., consisting of a float-operated sender located over a stilled-water chamber, electrically connected to a graphic recorder or indicating device which may be housed at a distance. The sender is the novel part of the apparatus. It is equipped with two electrical contacts, one of which closes for a fraction of a second every time the water rises 0.05 ft., while the other closes when the float falls an equal amount. The contact is made by the tilting of a bent metal tube in each leg of which is a mercury column. When the angle in the bent tube is lower than the end of the long leg, contact is effected. The recorder is equipped with two sets of magnets to operate a horizontal



VACUUM-FEED CHLORINATOR

drum above which is a clock-operated pencil carriage. Energizing one of the magnets which takes place whenever the circuit of the sender is closed operates a ratchet turning the drum one way when the water falls and the other way when it falls.

The Corcoran wipe joint machine exhibited by the A. T. Taft Manufacturing Co., Cleveland, consists of a clamping vice to bring together and hold steady the ends to be wiped. A split metal mould is then clamped around the pipe ends. After molten lead is poured into the mould the mould is partially revolved in both directions to make a smooth joint. It is claimed that four joints can be made by unskilled labor in the time it ordinarily requires a skilled mechanic to make one joint.

Split sections of 6-in. cast-iron pipe made by the de Lavaud centrifugal process were shown. The mould is revolved rapidly while the molten metal is poured in from the end of a cantilever pouring trough which is slowly withdrawn as it pours the length of the pipe. The exhibit was by the U. S. Cast Iron Pipe & Foundry Co.

A water-service pipe packer was developed recently for New Orleans by the Ford Meter Box Co., to remove service cocks at the curb and thus save digging up the street to shut off the corporation cock. It consists of an expander on the end of a long rod inserted through a stuffing-box head which screws into the service cock. When the expander has closed off the water the stuffing-box head is removed and then the old service cock is repaired or replaced, the head put back, the expander removed and the cock closed.

Wallace & Tiernan exhibited a new vacuum-feed chlorinator which consists of a chlorine pressure-reducing and constant rate-of-control mechanism housed under a water-sealed glass bell jar in a hard rubber tray at the top of a cast-iron pedestal. Located in the base of the tray is an injector for making a solution of chlorine and water, both of which are supplied through float-controlled pressure reducing valves. The vacuum produced by the flow of water through the injector produces a vacuum in the bell jar. This vacuum is transmitted to the bell jar through a glass orifice meter-tube assembly containing a silver tube adjustable as to height to control the water and chlorine differentials created by the vacuum.

Inside the bell jar, in addition to the ball-float reducing valve and meter tube, is a ball-float vacuum relief to admit air if the water supply is turned on without the chlorine. It prevents the water rising to the height of the gas-inlet connection.

The apparatus will function with chlorine pressures as low as 25 lb. and safety is insured, because the chlorine is automatically shut off with the water.

Water-Works Convention

(*Concluded from p. 885*)

Baltimore, chairman, Publication Committee; George C. Andrews, Buffalo, chairman Finance Committee, and Theodore Leisen, Detroit, chairman Membership Committee. The new nominating committee announced George W. Fuller's name as candidate for president for 1923-4.

The Water-Works Manufacturers' Association elected as president Edgar Buttenheim, of *The American City*, New York City, and re-elected the following: Vice-president, Charles R. Wood of R. D. Wood & Co., Philadelphia; treasurer, G. F. O'Brien, of the A. P. Smith Manufacturing Co., East Orange, N. J.; secretary, John A. Kienle, of the Mathieson Alkali Works, 25 West 43d St., New York City.

Detroit Gets Next Convention

For the next convention the executive committee announced duly accredited invitations from Detroit, Omaha, and San Francisco; the latter city waived all claims for 1923 with hopes for 1924. The ballot gave Detroit the convention with 182 votes, against 12 for San Francisco and 10 for Omaha.

On affiliations with or contributions to other associations the Executive Committee announced its decision against pledging the association to contribute from its treasury any part of the $2,500 requested by the (Joint) American Committee on Electrolysis. Last year private subscriptions for this work totalled $1,800. The Executive Committee also reported adversely on joining the American Construction Council or the National Fire Protection Association.

The Engineer in Public Life

THOMAS R. AGG

Service as a member of the Board of Education of the City of Ames, Iowa, is among the public activities of Thomas R. Agg, professor of highway engineering at Iowa State College and consulting road engineer to the Iowa Highway Commission. He is 44 years old, was graduated from Iowa State College in 1905, taught for three years at the University of Illinois and then served with the Illinois Highway Commission from 1908 to 1913 when he joined the faculty of Iowa State College. Prof. Agg has taken a prominent part in the activities of national local engineering societies, and in addition is a member of the Ames Chamber of Commerce. He is author of "Construction of Roads and Pavements" and "American Rural Highways." During the war he served in this country as captain, 109th Engineers, 34th Division, and later was promoted to rank of major and assigned to the 98th Engineers.

U. S. Chamber of Commerce Holds Highway Session

For the first time in its ten-year history the U. S. Chamber of Commerce devoted a session at its annual convention in Washington, D. C., last week, to highway transport. The meeting was held May 16 under the auspices of the transportation department of the chamber and was presided over by A. J. Brosseau, president of the International Motor Co., and director of the chamber, with J. R. Bibbins as secretary of the session. The speakers were Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads, who spoke on "Economic Foundation for Future Progress," and E. J. Mehren, editor of *Engineering News-Record* on "Practical Highway Transport Regulation."

Mr. MacDonald's paper was a careful inquiry into the factors needing consideration in the framing of a sound financial policy. He contended that highways should be placed in the self-supporting class of public improvements. Among other things he suggested that there was no good reason why highway bonds should be amortized within the life of the road, since experience has shown that there are certain permanent elements in highway improvement. He maintained that sufficient revenues must be derived from the users of highways to pay all of the maintenance and a percentage of the reconstruction charges. New construction would be paid by bond issues. An abstract of the paper will appear in an early issue.

Mr. Mehren's paper, printed elsewhere in this issue, pleaded for sane regulation, designed to increase traffic and secure maximum economic benefits.

Propose Five-Year Courses for Engineers

Deans of Fourteen Universities and Colleges Agree to Advocate Plan for Their Schools

Five-year courses for engineering students were unanimously favored by a conference of the engineering deans, directors and representatives of fourteen colleges and universities held in Chicago May 19. Each of the deans is to present the recommendations approved at the conference to his engineering faculty and to his president and will urge their adoption. It is hoped that this concerted action will bring about the publication of new five-year courses of study in time to become effective not later than 1924.

The resolutions that embody the conclusions of the conference and the names of the participants follow:

The undersigned engineering deans, directors and representatives, in conference assembled, hereby

Resolve, That in order to meet the constantly enlarging responsibilities of the engineering profession we favor an advance in engineering education at this time that shall provide for five years of collegiate training for those engineering students whose aim is to be qualified to take positions among the creative leaders in the profession, and that such advance shall be made in accordance with the following plan:

1. Remodel the present four-year engineering curriculums by substituting a substantial proportion of humanistic and fundamental subjects in place of an equivalent amount of advanced technical work. It is desirable that so far as possible the curriculums in the different branches of engineering shall be sufficiently uniform to permit students to defer their final choice of a specialty at least to the end of the second year.

2. Add a fifth year of advanced work, mostly or wholly technical and specialized to such an extent as desired.

3. The first four years of work shall lead to a bachelor's degree, and the fifth year to an advanced degree in engineering.

Resolved: That each member of this conference will present the above recommendations to the authorities of his institution, and will report back at the second session of this conference, which is to meet at Urbana, Illinois, during the week of June 18, 1922:

Dean W. G. Raymond, State University of Iowa, chairman.
Dean O. M. Leland, University of Minnesota, secretary.
Dean E. A. Hitchcock, Ohio State University.
Dean A. A. Potter, Purdue University.
Dean M. E. Cooley, University of Michigan.
Dean G. W. Bissell, Michigan Agricultural College.
Dean C. R. Richards, University of Illinois.
Director J. F. Hayford, Northwestern University.
Prof. Edward Bennett, University of Wisconsin.
Dean E. J. Babcock, University of North Dakota.
Dean O. J. Ferguson, University of Nebraska.
Dean Anson Marston, Iowa State College.
Dean W. E. McCourt, Washington University.
Dean H. S. Evans, University of Colorado.

City Bonds at Low Interest Rates

Woonsocket, R. I., has just sold $575,000 of 4½-per cent bonds which are being offered by the purchasing bond house at par. Watertown, N. Y., has sold $375,000 of serial 4½ per cent due annually from 1925 to 1945, which are now for resale by the broker to yield 4.05 at all maturities.

Enjoins New York City Project for Narrows Tunnel

On the application of William J. Shiefflin, chairman of the Citizens Union, a temporary injunction has been granted restraining the City of New York from proceeding with the Narrows Tunnel project. (See *Engineering News-Record*, April 13, 1922, p. 626, and May 18, p. 846.) The action alleges that the project is beyond the authority of the Board of Estimate and Apportionment and that it will involve the waste of from $60,000,000 to $100,000,000 of public funds on an impracticable scheme.

Headings Holed Through on Shandaken Tunnel

Headings between shafts 5 and 6 of the 18-mile Shandaken tunnel, forming part of the Catskill water-supply system for New York City, were holed through May 20.. After the ceremony luncheon was served in the tunnel, which had been decorated for the occasion, to a party of about 150, headed by J. Waldo Smith, chief engineer of the Board of Water Supply and including other members of the board's engineering staff, guests and representatives of the contractor, the Shandaken Tunnel Corp., with which the Ulen Contracting Corp., (T. S. Shepperd, vice-president and general manager) is associated. The first pair of headings, between shafts 4 and 5, had been holed through in March.

Cement Trial Nears Close

The case against the cement manufacturers of the Eastern district, who are being tried for violation of the Sherman anti-trust law in the federal court for the Southern district of New York, was scheduled to go to the jury this morning. The government began its summing up argument on Monday and the prosecution closed its rebuttal on Wednesday. A verdict is expected some time today.

American Construction Council Gains Headway

Much activity is being displayed by the temporary operating committee which has arranged for the organizing meeting in Washington, D. C., June 19 of the American Construction Council. Representatives of the committee put the matter last week before the national executive board of the Associated General Contractors meeting in Washington; before the Philadelphia convention of the American Waterworks Association and the meeting of the U. S. Chamber of Commerce in Washington.

The board of the Associated General Contractors voted to support the council, while the members of the waterworks association adopted a resolution that it was the sense of the convention that the association should take membership in the council. The purposes of the proposed organization were presented before the U. S. Chamber of Commerce by Arthur S. Bent, president of the Associated General Contractors, who spoke immediately before President Harding addressed the chamber.

Harrington Nominated for Presidency of A.S.M.I.

John Lyle Harrington, of Kansas City, Mo., was chosen by the nominating committee of the American Society of Mechanical Engineers at the spring meeting held in Atlanta, Ga., May 8-11, as candidate for president of the society to succeed Dean Dexter S. Kimball, of Cornell University, whose term of office expires this year. Mr. Harrington is a member of the firm of Harrington, Howard & Ash, consulting engineers, of Kansas City. Most of his professional experience has been in bridge work.

J. Waldo Smith Resigns

(*Concluded from p. 884*)

George S. Webster. He was awarded the John Fritz medal in 1918 in recognition of high engineering achievement and during the same year received honorary degrees of doctor of engineering from Stevens Institute of Technology and Columbia University.

At its meeting of May 23 the Board of Water Supply accepted Mr. Smith's resignation and appointed Thaddeus Merriman as chief engineer to succeed him. To those who have been associated with him on the Catskill work Mr. Smith sends the following message:

FROM "THE CHIEF" TO HIS MEN

"In announcing my resignation as chief engineer it seems fitting to address a message to the past and present members of the engineering organization, to the contractors and to others who have wrought with us, expressing my deep and lasting appreciation of their helpfulness and support throughout, their spirit of cordial co-operation, their many kindnesses to me personally and their self-sacrifice and loyalty to the work. Our distinguished consulting engineers have very aptly and truly stated publicly that, for ability, efficiency, integrity, loyalty and devotion to duty, the organization has seldom been equalled and never excelled by any other within their knowledge. By reason of this I feel that degree of obligation for all that has been done for me and for the ever-present helpfulness extended that I could not take this step if I believed it would react against the interests of the organization or the work.

"These have been exacting years, but they have been supremely happy ones. The human side and the personal relations have been intensely interesting and have been a source of recreation and real joy. It is my wish that, as the years go by, all who have been connected with the work may look on their service with the Board of Water Supply as I know I shall—as a real event in their lives.

"As in the past, the principle of promotion within the organization has been followed, and no stranger will head the engineering staff. In the position of consulting engineer, while this work will still be my chief interest, I hope to have more leisure to consider the developments of the future. Be assured that my interest in the organization's personnel and the welfare of the work will continue unabated. I bespeak for my successor the loyal support which has been the distinguishing characteristic of this work."

Engineering Societies

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, Salt Lake City, Utah, June 5-7.

NATIONAL CONFERENCE ON CITY PLANNING, Boston, Mass.; Annual Meeting, Springfield, Mass., June 5-7.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Annual Convention, Portsmouth, N. H., June 21-22.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Convention, University of Illinois, June 20-23.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Annual Meeting, Atlantic City, N. J., June 26-30.

The Engineer's Society of Pennsylvania has elected the following officers for the year: President, T. E. Seelye; first vice-president, R. W. Moorehead; second vice-president, William Brown; secretary, Howard E. Moses; treasurer, Harry T. Neale.

The Engineering Institute of Canada will hold a professional meeting in Vancouver, B. C., June 16 and 17.

Personal Notes

PAUL STARRETT has resigned as president of the George A. Fuller Co., but will continue to serve as director. James Baird who has been in charge of the Washington office for twenty-two years, has been elected president and will make his headquarters in New York.

LORENZO C. DIEKS, who was in charge of the shipbuilding undertaken during the World War by the George A. Fuller Co. at Wilmington, N. C., has resigned his position with that company upon the completion of the work there.

F. M. REGISTER, formerly in the chemical department of the Barrett Co., Frankford, Pa., is now with the L. Martin Co., manufacturers of lamp black, as superintendent of their Tacony, Philadelphia, plant.

B. H. PIEPMEIER, road engineer of the Illinois State Division of Highways, has been appointed chief engineer of the Missouri State Highway Department, succeeding Alexander Graham, resigned. A biographical sketch of Mr. Piepmeier will appear in next week's issue.

BERT H. CALKINS has been appointed city manager of Albuquerque, New Mexico, and will assume his new duties on June 1. He succeeds James N. Gladding who resigned on April 5.

JOHN LAYLIN, formerly a division engineer in the Ohio State Highway Department, has been appointed superintendent of public works, Columbus, Ohio, succeeding E. S. Smith, resigned.

H. A. TERREAULT, has been appointed director of public works, Montreal, Canada, succeeding A. E. Doucet, resigned. He was formerly superintendent of the city water works.

DANIEL P. POWERS, construction engineer for the Stebbins Engineering Co., Watertown, N. Y., is returning from Rajamundry, India, where he has been in charge of the construction of paper and pulp mills for the Carnotic Paper Mills, Ltd.

CHARLES R. MCELLEN, formerly with the New York State Highway Department, has become associated with James P. Brownell, consulting engineer, Watertown, N. Y.

M. G. SNOW, formerly assistant engineer in the valuation department of the New York Central R.R. at Cleveland, Ohio, has become cost engineer with the Froehlich & Emery Engineering Co., Toledo, Ohio, who are appraising all the interurban railways of the state of Michigan for the public utilities commission.

ROLAND E. STOELTING has been appointed commissioner of public works at Milwaukee, Wis. He was formerly assistant city engineer and engineer of the Board of Public Land Commissioners.

W. F. STROUSE, chief engineer of the public service commission, Baltimore, Md., has been made valuation engineer. H. CARL WOLF, assistant engineer, will be made chief engineer.

JACOB LABISHINER, recently associated with the Great Western Gateway Project at Schenectady, N. Y., has been appointed city engineer of Amsterdam, N. Y.

Business Notes

The ILLINOIS ZINC CO., manufacturers of zinc shingles, slab zinc, strip zinc in coils, electrolytic slab zinc, sulphuric acid and zinc dust, has opened a selling office for its products in Chicago.

ARTHUR MCMULLEN CO. announces the resignation of F. P. Parker and the election of Edward P. Palmer, as secretary of the company.

THE KEYSTONE CONCRETE BLOCK CO., Rochester, N. Y., has been appointed vicinity representative of the Consolidated Expanded Metal Co., Braddock, Pa., for the distribution of steelcrete "Rid-gid" metal lath.

The ASSOCIATED ENGINEERS, INC., engineers, constructors and managers of Milwaukee, Wis., has established a quantity-survey service.

WILLIAM S. MOORE, formerly city engineer of South Bend, Ind., has resigned as vice-president and general manager of the Bethlehem Spark Plug Co., Bethlehem, Pa., and formed an engineering partnership with CHARLES W. COLE, a member of the Indiana Board for the registration of engineers and surveyors. The firm has offices in South Bend.

Equipment and Materials

A Special Contractors' Truck

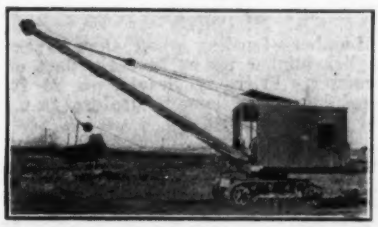
A contractors' truck, with a 10-ft. wheel base and a special dump body, has been put on the market by the Atterbury Motor Car Co., Buffalo, N. Y. Designed primarily for carrying batches of concrete materials, the 2-cu.yd. body is fitted for general haulage. A Heil hydraulic hoist giving a 43-deg. dumping angle gives precise control in dumping and the use of the chain spreading

device on the tail gate makes it possible to use the truck for stone spreading.

The body is fitted with steps on both sides so that men can spread and level the load. All corners are rounded to facilitate scavenging, and the rear end of the body is fitted with slanting plates to confine the load to the skip when dumping. This feature, in connection with the swinging lateral partition, allows both batches to be dumped into the skip without moving the truck.

New High-Power Excavator

To meet the demand for a larger size excavator designed to come within standard railway clearances without dismantling, a new machine is now being placed on the market by the Pawling & Harnischfeger Co., Milwaukee, Wis. This machine will handle a 1-cu.yd. dragline bucket on a 35-ft. boom, a ¾-cu.yd. bucket on a 40-ft. boom or a ½-cu.yd. bucket on a 50-ft. boom. It will also handle clamshell buckets of



from ½- to 1½-cu.yd. capacity depending upon the material handled. With but a few unimportant changes the machine can be converted into a gas shovel handling a 1-cu.yd. dipper. In addition to being used as a gas shovel or with clamshell and dragline buckets, the machine can be used with backfilling scraper, crane hook or electric magnet.

The excavator has four movements forward and in reverse on its crawler tractions. The power unit is a 75-hp. gas engine.

Business Side of Construction

Facts and Events that Affect Cost and Volume

What Materials and Labor Cost in Milwaukee

Higher Lumber Prices Forecasted During Summer—All But Iron-Workers Busy—Detailed Prices

Among the cities not covered in the Monthly Prices of Construction Materials or the Weekly Construction Market of *Engineering News-Record*, Milwaukee is the next to receive consideration in these pages. Materials prices and labor rates in Buffalo were published on Jan. 19, p. 132. Other buying centers not included in the regular price lists will be featured from time to time, from information obtained first hand by our regular correspondents.

Following quotations are to contractors, in car lots unless otherwise stated:

Sewer Pipe—Current prices per ft., in the following sizes:

3-in. diameter	$0.18
5-in. diameter	.27
8-in. diameter	.42
12-in. diameter	.81
24-in. diameter	2.48
36-in. diameter	5.13

Sand, Gravel and Crushed Stone—Gravel, 1½-in. screen, quoted at $2.10 per cu.yd. Sand prices range from $2.20 to $2.40 per cu.yd. Crushed stone, both 1½-in. and ¾-in., $2.25 per 2,500 lb.

Cement—Natural (Louisville) cement sells for 90c. per sack; portland cement at $2.16 per bbl., without bags, f.o.b. Milwaukee.

Lime—Hydrated common lime $10 per ton at warehouse, including cloth bags; common lump per bbl., 180 lb. net., $1.60.

Brick—Chicago common brick quoted at $13.50 per 1,000. Milwaukee brick costs $12.50; Hy-tex rustic at $37.50 and tapestry brick at $45.

Hollow Wall and Clay Drain Tile—Price per block for hollow wall tile, 4 x 12 x 12, 8c.; 8 x 12 x 12, 14½c. Clay drain tile quoted per lin. ft., in the following sizes:

3-in.	$0.05
4-in.	.06
6-in.	.09
8-in.	.14

Lumber—Leading wholesalers expect higher lumber prices in early part of summer. Prices wholesale, per M ft. b.m., in carload lots, to dealers, f.o.b.; for No. 1 grades:

Yellow pine, 1-in. rough, 10-in. and under, 16 ft. and under	$37
Fir, 1-in. rough, 10-in. and under, 16 ft. and under	37
Hemlock, 1-in. rough, 10-in. and under, 16 ft. and under	37
Yellow pine, 2-in. tongue and groove, dressed and matched, 10-in. and under, 16 ft. and under	38
Fir, 2-in. tongue and groove, dressed and matched, 10-in. and under, 16 ft. and under	38
Yellow pine, 8x8-in. and under, 20 ft. and under	42
Fir, 8x8-in. and under, 20 ft. and under	42
Hemlock, 8x8-in. and under, 20 ft. and under	42
Spruce, 8x8-in. and under, 20-ft. and under, including jack pine balsam	52
Yellow pine, 12x12-in., 20 ft. and under	51
Fir, 12x12-in., 20 ft. and under	51
Maple, factory grade, 1x2½-in. m. and d.	30
Maple, clear, 1x2½-in. m. and d.	100
Oak, 1x4-in. m, d and b.	175
Wood lath, No. 1 hemlock, per M	10
No. 1A, hemlock, per M	8.50
No. 1 pine, per M	12

Expanded Metal Lath—Prices per sq.yd., are as follows:

Gage	
27 dia. mesh	$0.21
27 herringbone	.22
26 dia. mesh	.23
24 herringbone	.28½
24 dia. mesh	.27½

Pyrobar—

	C.L.	L.C.L.
3-in. per sq.ft.	$0.10½	$0.11
4-in. per sq.ft.	.13	.13½
5-in. per sq.ft.	.20	.....
6-in. per sq.ft.	.22	.....
3-in. roof tile	.22	.24
3½-in. hollow roof tile	.22	.24
4-in. hollow roof tile	.23	.25
Book tile per piece	.15	.16

LABOR RATES PER HOUR AND CONDITIONS

Bricklayers	$1.00	Plenty of work
Lathers	1.00	.....
Carpenters	.85	Plenty of work, best receive 90c. per hr.
Painters	.80	.....
Hoisting engineers	.92½	No standard wage, paid on merits.
Plumbers	.90	Effective since May 15; formerly $1 per hr.
Hod carriers	.50	.....
Pile drivers	.50@.75	No standard wage; based on individual merits.
Plasterers	1.10	.....
Structural iron-workers	1.00	Not much demand.
Common labor, non-union	.40	Obtainable at 35c.

Steel and Iron in April and March

United States steel orders at the end of April were 5,096,917 tons as compared to 5,845,224 tons for the corresponding period in 1921. Daily pig iron production for April was 69,070, a great increase over the same period of last year when 39,768 tons daily were reported. April's total production of pig iron is estimated at 2,072,114 tons in comparison to 1,193,041 tons last year.

At the end of March, United States steel orders amounted to 4,494,148 tons compared to 6,284,765 tons for the corresponding period of 1921. Daily pig iron production for March, 1922, was 65,631 tons and 51,463 tons for 1921.

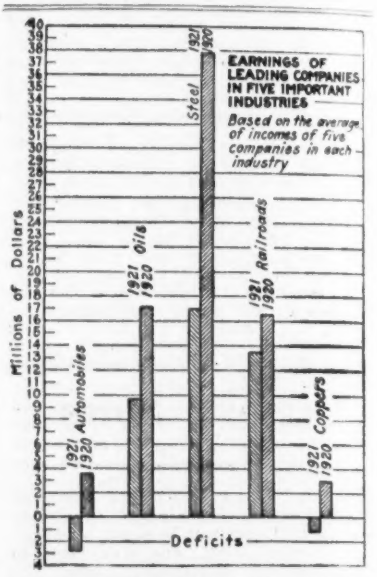
A decrease in the number of employed in eight industries and an increase in four others during the month of April, as compared with March, is reported to the Department of Labor by twelve representative manufactories.

Cost of money at New York last week was 3½@3 per cent.

Corporate Earnings Chart Shows 1921 Losses

Yearly financial statements of twenty-six well-known American business organizations, as reported to newspapers, show seven returned deficits in 1921 as compared with only one in 1920.

Largest gains in the accompanying table of earnings were made by Wells Fargo & Co., the Magma Copper Co., American Power & Light Co. and Pere Marquette Ry. Co. Returned deficit of the Braden Copper Co. was $5,013,720. (Sixty-six other financial statements from well-known companies were reported in the April 27 issue *Engineering News-Record.*)



Taking the average of five leading companies' earnings for 1921 and 1920, the comparison in the following chart shows that in each group 1920 profits were appreciably larger than those for the year 1921.

Company	Net Earnings or Losses (Deficits shown in italics) Total 1921	Total 1920
American Power & Light Co.	$1,003,178	$967,240
Anaconda Copper Mining Co.	*16,999,555*	.....
Braden Copper Co.	*5,013,720*	*2,279,938*
Chicago & Northwestern Ry. Co.	*1,245,438*	12,459,253
Chicago, St. Paul, Minneapolis & Omaha Ry.	*285,677*	2,587,669
Colorado Power Co.	383,589	.....
Crescent Pipe Line	168,666	146,102
Havana Electric Ry.	4,620,064	4,108,510
Hurley Machine Co.	429,309	706,663
International Cement Co.	1,529,900	.....
Kennecott Copper Co.	3,799,392	6,477,021
Lanston Monotype Machine Co.	477,877	.....
Magma Copper Co.	*289,830*	102,545
Merritt Oil Corp.	999,456	.....
Mutual Oil Co.	1,257,689	.....
Ohio Fuel Supply Co.	2,293,524	.....
Pere Marquette Ry. Co.	3,765,879	1,393,972
Steel & Tube Co. of America	*2,571,352*	6,315,209
Sterling Products	2,057,703	.....
Standard Oil Co. of New York	9,698,971	39,405,631
Union Pacific R. R.	31,301,074	32,674,231
Utah Copper Co.	*2,058,109*	4,924,498
Vacuum Oil Co.	6,158,566	8,386,783
Wells, Fargo & Co.	1,279,707	453,041
Western Pacific R. R. Co.	2,808,533	.....
White Eagle Oil & Refining Co.	790,808	.....

Business Briefs

Gold money in the world in estimates submitted in connection with the Genoa conference will have reached £2,277,000,000 in 1930. This would compare with £1,916,000,000 in 1918, and £733,000,000 in 1891.

Gold imports last month amounted to $12,243,555, as compared with $33,488,256 in March and $80,662,202 in April, 1921, according to the Department of Commerce.

Building trades wages have been reduced on the average of 16 per cent since Jan. 1, the National Industrial Conference Board reports. Twenty-eight decreases were noted, eighteen occurring in the last two months and confined largely to the East and Middle West.

Wholesale prices of most commodities in April varied little from those of the preceding month, according to the Bureau of Labor Statistics, the all commodities index remaining the same as March.

New railroad equipment, consisting of 20 locomotives, 5,390 steel freight cars, 500 steel automobile cars, 100 steel passenger cars and 250 caboose cars, has just been ordered by the Southern Railway System as evidence of its faith in the early return of business prosperity in the South.

Gross domestic crude oil stocks held in pipe line and tank farm storage in the United States increased 9,583,000 bbl. in April, reports the American Petroleum Institute. The increase east of the Rockies was 7,763,000 bbl. and in California, 1,820,000 bbl.

Gross railroad earnings for the second week in May amounted to $7,416,004 in comparison to $7,157,170 for the corresponding period in 1921, showing a gain of $258,834 or 3.61 per cent.

Freight Car Surplus Decreases Five Per Cent in Week

In the fifth complete week of the bituminous coal miners' strike, that ending Saturday, May 6, 1922, revenue freight loading substantially maintained the figure of the previous week, the decrease being only 2,537 cars. Coal and coke in the aggregate were practically stationary. Grain and grain products, live stock and merchandise l.c.l., showed slight increases, while there was a decline in the loading of forest products, ore and miscellaneous freight. Compared with the corresponding week of the previous year the week's total of 755,749 was an increase of 34,027 cars despite the natural decline in coal loading due to the strike. The only other commodity which fell off compared with 1921 was ore. Compared with the same period two years ago the decrease in the total loading of 1922 was 87,435 cars. In the week ending May 8, 1922, there was a decrease of 18,299 freight cars or approximately 5 per cent, in the surplus, the total being 353,239 cars against 371,538 for the period ended April 30th. Surplus coal cars totaled 226,276, surplus box cars 86,604. The balance were miscellaneous.

1921 New York Road Contract Prices Fell Heavily

Data Based on 3,175 Miles for Seven Years Gives an Index Number of 214 for 1920 Compared to 208 Last Year

By W. G. Crandall
Assistant Engineer of the New York State Highway Commission

Contractors' prices index number on items entering into contracts awarded by the New York State Commission of Highways for the years 1915 to 1921 inclusive, shows 208 for the year 1921 in comparison to 214 for 1920, the peak year. Data was compiled from bids received on approximately 3,175 miles, extending over a period of seven years. It is interesting to note that the highest average bid price for 1921 is lower than the 1920 general average on earth excavation, foundation course and cement concrete pavement. Following are the values, the average bid price for 1915 is given an index value of 100.

Item	1915	1916	1917	1918	1919	1920	1921
Clearing and grubbing	100	197	200	114	136	106	208
Earth excavation	100	116	140	238	253	349	267
Rock excavation	100	113	120	170	195	233	221
Overhaul	100	80	100	133	153	171	127
6-in. vitrified pipe	100	105	275	...	185	300	195
8-in. vitrified pipe	100	109	143	...	191	215	211
10-in. vitrified pipe	100	103	133	...	188	230	263
12-in. vitrified pipe	100	108	142	140	210	244	262
15-in. vitrified pipe	100	122	140	...	205	265	267
16-in. vitrified pipe	100	78	169	...	165	...	...
18-in. vitrified pipe	100	104	126	...	184	239	234
20-in. vitrified pipe	100	90	175	...	220	...	224
24-in. vitrified pipe	100	104	124	...	183	165	193
6-in. vitrified pipe underdrain	100	105	135	175	200	230	210
6-in. porous tile underdrain	100	85	120	115	155	180	150
Concrete leaching basins, type A	100	130	135	...	187	191	180
Vitrified leaching basins	100	84	...	...	170	...	174
Catch basins	100	108	148	83	184	157	191
Changing elev. of catch basins	100	127	117	234	231	173	229
Cast iron pipe	100	118	149	158	233	245	248
Relaying old pipe	100	108	91	88	129	135	171
Stone filling	100	131	148	190	256	318	240
Piles, wood	100	63	70	...	...	...	204
Timber and lumber	100	136	154	157	199	271	261
Riprap	100	115	131	150	200	229	222
First class concrete	100	62	...	...	107	159	129
Second class concrete	100	105	118	135	168	242	213
Third class concrete	100	110	126	153	188	282	233
Stone masonry	100	105	122	135	207	261	182
Stone curbing	100	120	133	...	167	211	235
Resetting old curb	100	103	...	...	163	140	230
Concrete curb, type A	100	115	144	163	202	235	210
Concrete curb, type B	100	112	136	...	229	...	191
Concrete edging	100	133	167	...	367	...	...
Cobble gutter, cement joint	100	109	115	174	184	200	150
Cobble gutter, sand joint	100	112	123	172	190	252	190
Concrete gutter	100	148	152	...	252	271	275
Brick gutter	100	100	...	...	165	...	...
Metal reinforcement	100	103	123	179	151	170	144
Misc. iron and steel	100	103	123	149	150	164	139
Wood guide railing	100	112	140	146	200	267	262
Pipe railing	100	109	147	...	165	192	229
Guide signs	100	111	129	150	156	180	200
Hyway number signs	100	118	80	93	99	112	97
Danger signs	100	111	142	147	229	210	238
Concrete sign posts	100	125	129	154	155	165	175
Screened gravel	100	91	111	172	155	153	178
Broken stone, loose meas. (ton)	100	118	122	94	189	...	185
Broken stone, loose meas. (cu.-yd.)	100	112	113	147	198	235	212
Foundation course, screened gravel	100	130	161	...	235	230	366
Foundation course, field or quarry stone	100	108	134	147	217	262	216
Bottom course, screened gravel	100	113	154	...	245	154	...
Bottom course, broken stone	100	111	125	169	190	221	193
Concrete foundation for pavement	100	109	134	104	200	300	241
Top course, waterbound macadam	100	110	124	163	213	241	193
Scarifying and reshaping old macadam	100	92	...	...	105	212	...
Surface treatment with bituminous material	100	101	128	109	145	138	...
Top course, bituminous macadam, penetration	100	110	117	187	197	220	208
Bitulithic pavement	100	...	113	...	137	...	...
Concrete pavement	100	109	144	237	203	274	239
Sulphite liquor	100	100	120	...	135	171	...
Asphalt block	100	136	116	...	...	...	174
Brick pavement, type I	100	111	126	157	199	...	210
Stone block	100	106	134	...	233	283	...
Bituminous material "A," penetration	100	102	119	191	120	223	136
Bituminous material "T," binder	100	93	105	183	141	125	...
Calcium chloride	100	112	111	103	150	171	...
Calcium chloride, manipulation	100	127	131	100	170	200	...
Average	100	110	133	151	186	214	208

SURPLUS AND SHORTAGE STATEMENT—MAY TO 8, 1922

Districts	Flat Cars Surplus	Flat Cars Shortage	All Box Cars Surplus	All Box Cars Shortage	All Coal Cars Surplus	All Coal Cars Shortage	Total All Cars Surplus	Total All Cars Shortage
Eastern	887	..	13,780	100	83,048	...	102,403	100
Allegheny	392	..	12,437	...	104,740	...	121,097	...
Pocahontas	162	..	791	...	1,954	...	3,926	...
Southern	2,199	7	7,569	124	4,770	737	18,779	875
North Western	796	..	21,451	50	2,611	...	30,841	50
Central Western	1,030	..	22,368	55	26,116	50	61,873	111
South Western	550	..	8,208	151	3,037	...	14,320	151
Total	6,016	7	86,604	483	226,276	787	353,239	1,287
Canadian Roads	1,745	..	26,975	...	1,340	...	36,765	...
Grand total	7,761	7	113,579	483	227,616	787	390,004	1,287
Apr. 30, 1922	9,162	84	122,688	369	236,787	374	410,203	842

Failures Gain in Week

Following last week's substantial reduction, business failures in the United States this week shows an increase, numbering 459. The total compares with 408 last week, and is considerably in excess of the 315 defaults reported to R. G. Dun & Co. a year ago. Of this week's insolvencies, 262 had liabilities of $5,000 or more in each instance, which represents 57.1 per cent of aggregate number. Last week, there were 233 failures for $5,000 or more.

April Residential Contracts Amount to $132,477,800

Residental contracts let for April amounted to $132,477,800, making a total of $405,451,500 for the first four months of 1922, according to F. W. Dodge construction figures. Total contracts for the first quarter amount to $273,000,000 as follows: $75,728,300 for January; $75,727,500 for February, and $121,550,900 for March.

Through an error *Engineering News-Record* in the May 11 issue published the Dodge residential construction figures as for the whole first quarter of 1922 instead of for the month of March only. Dodge's figures for March were $121,550,900. Residential contracts for the first four months of this year are as follows:

District	Value
Boston	$36,628,600
New York	176,835,200
Philadelphia	64,395,900
Pittsburgh	45,746,500
Chicago	74,264,300
Minneapolis	7,580,400
Total	$405,451,500

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of May 4; the next, on June 1.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$2.58	$3.50	$4.00	$2.48	$2.76	$3.50	$3.10	$3.60	$3.75
Structural rivets, 100 lb.	3.50	4.25	5.50	3.10	3.90	4.45	4.50	3.75	6.50
Reinforcing bars, ¾ in. up, 100 lb.	2.48	3.50	3.50	2.38	2.66	3.52½	2.55	3.60	2.75
Steel pipe, black, 2½ to 6 in. lap, discount	61%	61.15%	45%	59½%	61.9-5%	44%	56.1%	53%	30.00
Cast-iron pipe, 6 in. and over, ton	46.80@47.80	48.00	48.30	44.10	48.50	55.00	51.00	52.00	50.00
Concreting Material:									
Cement without bags, bbl.	2.50@2.60	2.39	2.25	1.97	2.24	2.90	2.83	2.94	2.48
Gravel, ¾ in., cu.yd.	1.75	1.85	2.25	1.80	1.50	2.50	2.25	1.50	1.50
Sand, cu.yd.	1.00	1.15	2.25	1.80	1.00	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.75	1.90	2.73	1.60	2.25	3.50	2.25	3.00	—1.60
Miscellaneous.									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	48.00	+38.00	34.50	40.00	39.00	+47.00	26.00	+21.50	47.00
Lime, finishing, hydrated, ton	15.80@16.80	18.00	25.00	18.00	29.00	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	2.75@3.18	1.25	2.50	1.40	1.40	2.70	1.75	2.80	11.00
Common brick, delivered, 1,000.	23.40	9.00	11.15	11.00	+16@17	12.00	15.00	14.00	16.00
Hollow building tile, 4x12x12, per block	Not used	.0795	.115	.0821	+.082	.08	....	.12	.09
Hollow partition tile 4x12x12, per block	.1112	.072	.115	.0657	....	.08	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	.95	—1.00	1.09	1.04	1.06	1.18	1.04	.86	.97
Common Labor:									
Common labor, union, hour	.75	.35	.....	.80	.....	.50@.55	.56¼	.50@.60	.....
Common labor, non-union, hour	.44@.60	.20	.25	.72½	—.35@.50	.35@.50	.47½@.50	.....	.20@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: **45-5%** means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir common.

Seattle quotes on Douglas fir instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks.

Montreal quotes on fir instead of pine. Sand, stone, gravel and lump lime per ton. Lime and tile are delivered; cement, sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 99.13 cents). Bag charge is 30c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½-in., $30; 6-in., $110.

Changes Since Last Week

Steel shapes, plates and bars firm at $1.60 per 100 lb., Pittsburgh; mill shipments, New York, $1.98. Rise expected in warehouse prices as quotations in effect at present are based upon $1.50, Pittsburgh. Iron and steel scrap prices up; coke also slightly advanced. Falling off in demand for fabricated steel but mills increasing production on semi-finished products.

Stiff advances in lumber. Denver quotes Douglas fir at $47 as against $36.75. Seattle $21.50 advanced from $20 and Atlanta quotes pine at $38 as compared with $36 per M ft., one week ago. Common brick in Minneapolis is now $16@$17 as against $15. Face brick is also up there, by $2, and hollow building tile has risen slightly. Crushed stone quoted at $1.60 as against $2 per ton in Montreal. Raw linseed oil $1 in Atlanta as compared with $1.05 per gal., 5 bbl. lots, one week ago.

Common labor quoted at 35c.@50c. in Minneapolis as against the former rate of 40c.@50c. per hr. Hod-carriers, recently on strike in New York, have returned to work; agreements on the wage rate of $7 per day or 87½c. per hr. having been effected. This schedule was maintained throughout 1921 and is to continue in force during 1922.

A total of 377 mills reporting to the National Lumber Manufacturers' Association for the week ending May 13, show 207,799,592 ft. cut, or a reduction of 2 per cent from the week ending May 6; shipments amounting to 226,826,577 ft., or a reduction of 1 per cent from the previous week and orders for 261,354,729 ft. as against 261,666,175 ft. b.m. for the week preceding. Orders reached 17 per cent and shipments 2 per per cent above normal, while production stood at 7½ per cent below.